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ELECTRONIC DATA INTERCHANGE

by

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Thesis Advisor: Myung W. Suh

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Electronic data interchange (EDI) is the intercompany, computer-to-computer exchange of business documents in standard formats. The direct benefits of EDI consist in cost savings, operational accuracy, and speedy processing of transactions. This thesis provides guidelines to develop an EDI (Electronic Data Interchange) system. It discusses the basic concepts, standards, data mappping, hardware and software requirements, and networking requirements. Also discussed are some auditing and security issues in implementing EDI.

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Electronic Data Interchange

by

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ABSTRACT

Electronic data interchange (EDI) is the intercompany, computer-to-computer exchange of business documents in standard formats. The direct benefits of EDI consist in cost savings, operational accuracy, and speedy processing of transactions. This thesis provides guidelines to develop an EDI (Electronic Data Interchange) system. It discusses the basic concepts, standards, data mappping, hardware and software requirements, and networking requirements. Also discussed are some auditing and security issues in implementing EDI.

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I. INTRODUCTION

Electronic data interchange (EDI) is the intercompany, computer-to-computer exchange of business documents in standard formats. Through EDI, such common business forms as invoices, bills of lading, and purchase orders are transformed to a standard data format and electronically transferred between trading partners.

Electronic Data Interchange (EDI) is fast becoming the standard way of exchangeing business documents, not only in this country but also in the rest of the world. EDI provides a faster, more accurate, less costly method of communication than do traditional methods of business communications such as mail, telephone, and personal delivery. However, EDI is doing more than just changing how businesses communicate; it is changing the way businesses operate. Electronic data interchange is changing industry. Trading relationships are changing, management philosophes are changing, and production techniques are changing.

The direct benefits of EDI are immediately apparent from its definition:

- *Saving:* EDI eliminates paper, postage premiums for overnight delivery, and the like. Rooms full of data entry personnel and equipment become obsolete.

- *Accuracy:* EDI communication is direct, instantaneous, and immediately verifiable. That means no more lost or misrouted mail. Documents exchanged are 100 percent accurate and complete. This make such jobs as reconciliation for payment much easier. All this provides additional savings.
- *Speed:* Instantaneous communication is an important EDI benefit to those companies that compete on cycle time. EDI is essential in supporting just-in-time(JIT) delivery schedules.

The costs and benefits of incorporating EDI into a business operation have been estimated by Price Waterhous as follows: For a typical $10 million company, the annual cost EDI costs will remain fairly steady between 10 and 12 million dollars per year. However, the annual saving for the company will increase each year yielding a total saving over the five year period of $200 million [Ref. 1: p. 27].

In the U.S., there are currently about 5,000 companies using EDI, and that number is expected to double annually for the next three years. Already in the automotive, chemical, pharmaceutical, and grocery industries, EDI has become a prerequisite for doing business -- that is, companies not currently EDI - capable are suffering a competitive disadvantage. Several other industries -- railroads, apparel, textile, retail, electronics, health care -- are not far from this level of EDI commitment. Growth of EDI in other industries will be rapid, as companies seek to leverage their EDI investments over all their trading partners. By 1993, an estimated 70 percent of U.S. businesses will make significant use of EDI [Ref. 2: p. 11].

EDI use is spreading internationally, as well. Virtually nonexistent as little as two years ago, the international EDI market is blossoming-particularly in Great Britain and Canada. There are now 900 major European companies using EDI and that number is expected to grow to 140,000 by 1995. Just as it would be almost unthinkable nowadays for a business not to have a telephone to communicate with customers and suppliers, it may be almost as unthinkable for a business not to have a computer for the same purpose.

II. EDI DEVELOPMENT AND STANDARDS

A. OVERVIEW

Standards are fundamental to EDI. EDI is the intercorporate exchange of business documentation in structured, machine-processable form. EDI is designed so that the receiving computer can read and process data without additional human intervention. This means that the data must be in coded rather than textual format. EDI standards provide a widely accepted format to convey the meaning of the exchanged data. They allow the sender to encode data in the same format for many receivers, and require the receiver to maintain only one piece of software to decode data received from many senders. Standards for EDI have been established and maintained by several organizations for a variety of business functions. EDI format standards are intended to enhance EDI transactions across industry lines and to foster a common *language* for cross-industry EDI system.

The first attempt to develop standards occurred in the late sixties in the transportation industry. In 1968, a group of companies in the transportation industry joined together and formed the Transportation Data Coordinating Committe (TDCC). The committee published its first standards in 1975 and has since developed and published standards used primarily in the air, motor, rail, and ocean carriers. Other industries followed the TDCC's lead and developed EDI standards for their own industries, most notably the grocery and the warehousing industries. The standards for the grocery industry are termed *Uniform Communication Standards* while the standards for the warehouse industry are termed Warehouse Information Network standard (WINS) [Ref. 3: p. 64].

In 1978, the American National Standards Institute (ANSI) recognized the need for national EDI standards that could be used across industries. ANSI is coordinator and clearing house for national and international standards whose membership represents nearly all technical disciplines and all areas of trade and commerce. ANSI coordinates standards for all facets of business. In 1979, ANSI chartered a new committee, labeled the Accredited Standards Committee (ASC) X12, to develop uniform standards for cross-industry electronic communications. According to the X12 committee, its function is to develop standards to faciliate electronic interchange of data relating to order placement and processing, shipping and receiving information, invoicing, and payment. The ANSI ASC X12 committee, using the basic structure and syntax established by TDCC, developed and continues to develop EDI standards

[Ref. 3: p. 66]. While TDCC-based standards and the ANSI X12 standards are not identical, they use the same basic architecture and employ similar syntax rules [Ref. 3: p. 67].

B. ANSI X12 STANDARDS

1. Organization of ANSI ASC X12

The American National Standards Institute (ANSI) has made a significant contribution to the development of Electronic Data Interchange transactions across industry lines, using standardized protocols. Since 1918, this organization has been responsible for approving engineering and industrial standards. ANSI does not actually establish standards. They are responsible for approving estandards that have been developed by committees of experts. ANSI uses a rigorous consensus-based process for the establishment of standards. As the official voluntary standard-setting organization for the United States, ANSI sanctioned the Accredited Standards Committee X12 (ASC X12) to develop the necessary standards. This committee was made up of representatives of commerical and industrial organizations, and vendors of services designed to facilitate the use of Electronic Business Data Interchange Standards. The scope of X12 is to provide standardization to facilitate interbusiness/institutional electronic interchange of transactions relating to order placement and processing; shipment and receiving information; invoicing; payment; and application data. The X12 organization is structured into committees and subcommittees as showen in Figure 1 [Ref. 3: p. 77].

The two major committees are the Steering Committee and the Procedures Review Board who are responsible for the following:

- Steering Committee performs administrative functions for X12 and provides coordination among subcommittees and task group.
- Procedure Review Board (PRB) reviews all project proposals submitted to the committee. It manages draft standards, standards maintenance, and compliance guidelines. [Ref. 3: p. 78]

In addition to the two major committees, there are nine standing subcommittees. Six of the subcommittees represent functional area interests : product data, materials management, purchasing, finance transportation, and government. Three of the subcommittees deal with issues of a broader nature. The Technical Assessment Subcommittee reviews draft proposals to determine if they are within the scope of X12's activities and also ensure the consistency within X12 standards. The Educational and Implementation Subcommittee acts as the public relations arm of X12. In addition to the two major committees and nine subcommittees two other groups play a part in the X12 organization. The Data Interchange Standards Association (DISA) acts as the secretariat for the

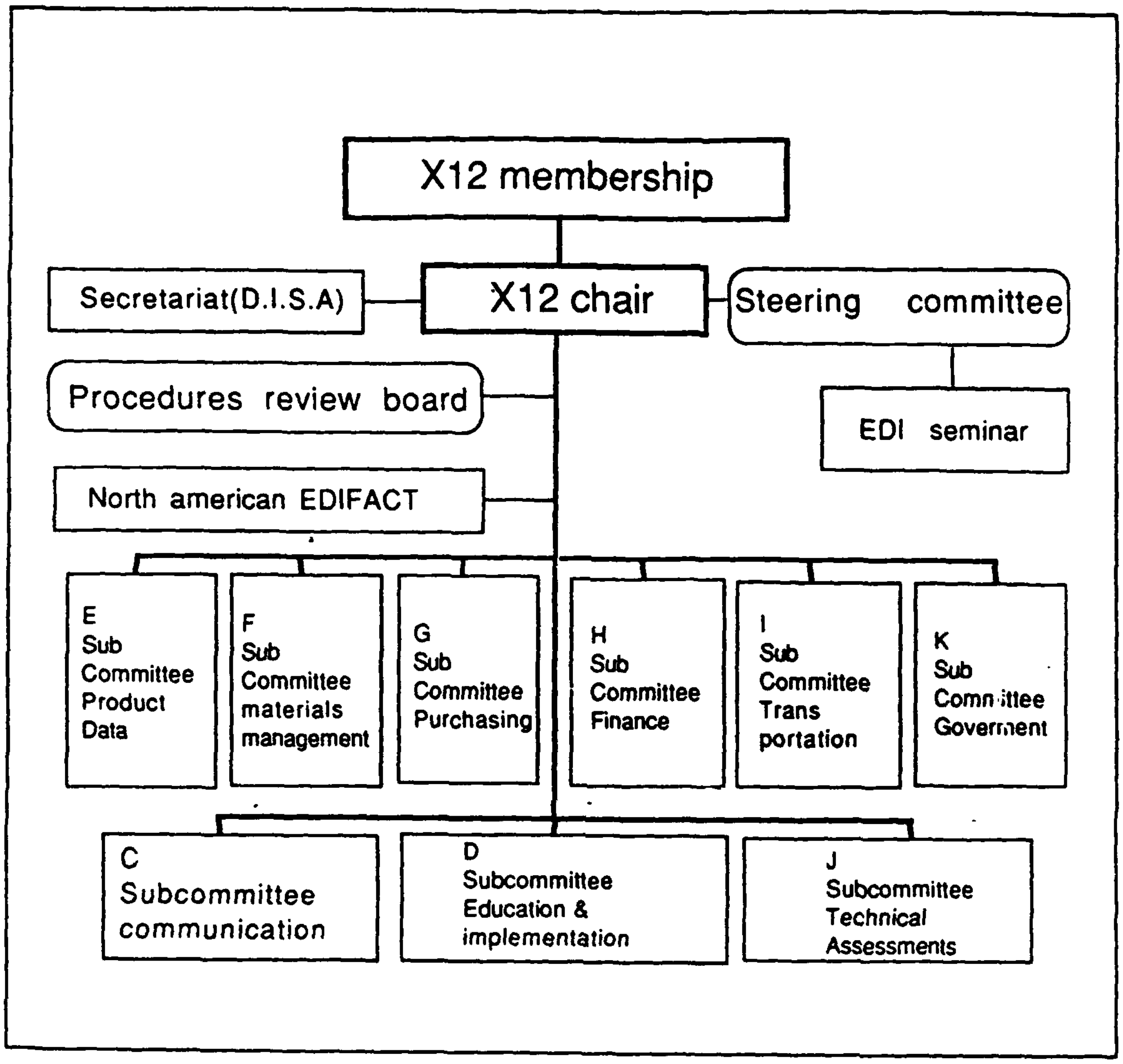

Figure 1. ANSI X12 organization

X12 organization. DISA performs administrative functions such as printing, distribution, and storage of the standards. The X12 organization also participates in development of standards on an international basis by having X12 members serve as representatives to the North American

EDIFACT (Electronic Data Interchange for Administration, Commerce and Transport) board.

Any individual or organization, whether a member of the X12 committee or not, can request that a new standard be developed, or that a change be made to an existing standard. Such a request is usually submitted to the secretariat, who forwards the request to the Technical Assessment Subcommittee, as shown in Figure 2 [Ref. 3: p. 80].

If the request is within the scope of X12, the Technical Assessment Submittee forwards the request to the pertinent subcommittee for review. The subcommittee prepares a formal project proposal based upon the work request, which is submitted back to the Technical Assessment subcommittee for a consistency check with other standards. If the proposal passes this check, it is sent to the Procedure Review Board for one more vote on whether the proposal is within the scope of X12 and is consistent with other standards. If this vote is positive, then the proposal is referred back to the original subcommittee for actual standards development. Final approval authority for all business-related standards, not only EDI standards, rests with ANSI. Whenever ANSI receives a proposed standard from any Accedited Standards Committee, such as X12, ANSI sends the proposed standard out for public review and comment, a process that can

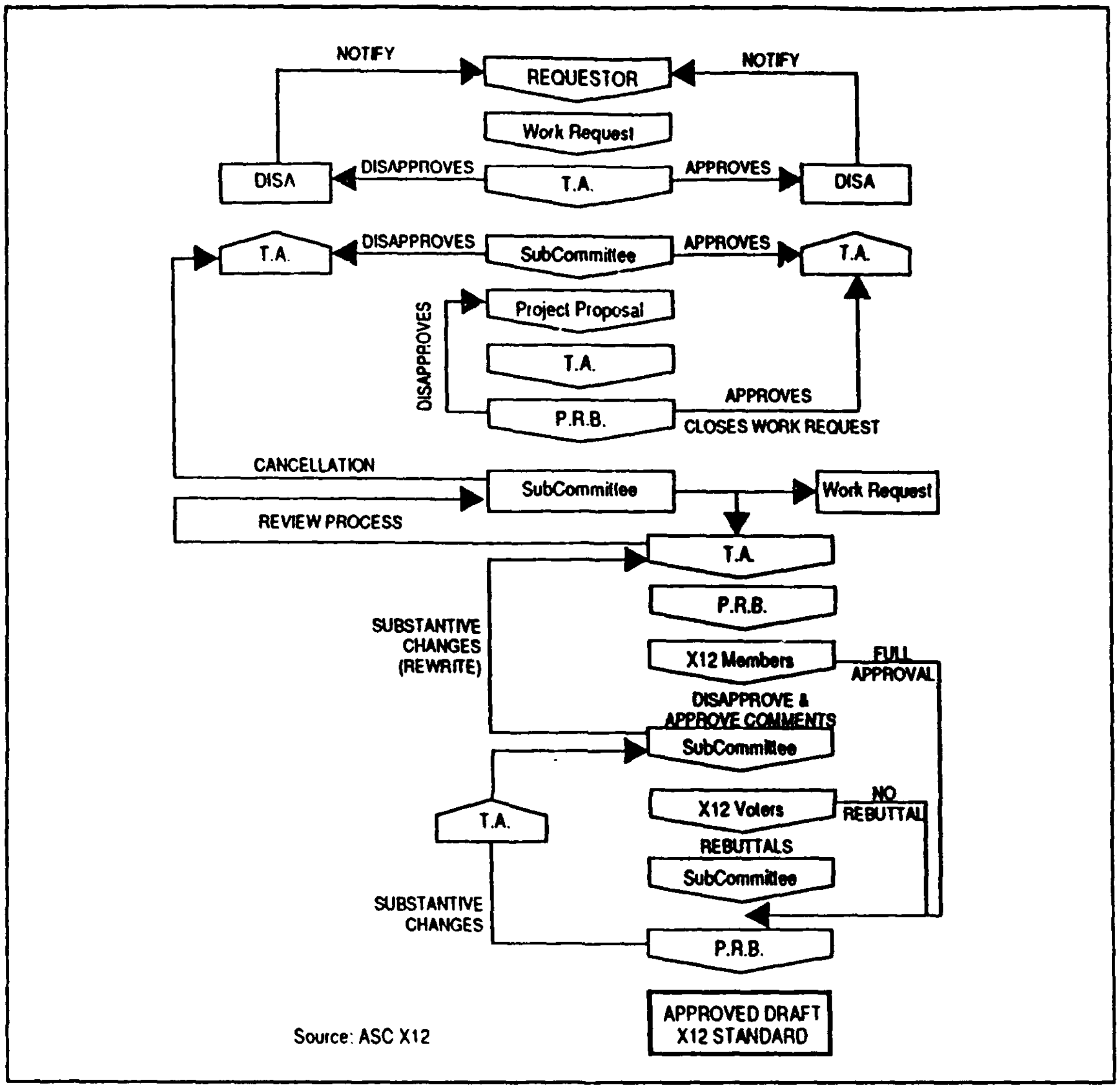

Figure 2. **ANSI X12 maintenance/development flow**

take two to three years. Only after the review process is completed is the standard approved and released as an ANSI approved standard. In the EDI community, standards are considered approved once they have been accepted by the X12 committee. So, although most ANSI EDI standards carry the offical title of *draft standards*, they are the standards in use and accepted by the EDI community [Ref. 3: p. 80].

2. Description of ANSI X12 standards

The X12 committee continued development of business transactions which would support the use of computers in the day-to-day interchange of business data. The ANSI X12 standards consists of:

- Transaction set standards
- Data element dictionary
- Data segment directory
- Transmission control standards. [Ref. 2: p. 63]

Transaction set standards define the format and context of data used within specified business documents, such as invoices. (The ANSI-approved transaction set standards are listed in Figure 3.) However, while the invoice transaction set (810) conveys the functionality of the paper invoice, it does not contain as much descriptive information, since it is not intended for human reading.

The *data dictionary* contains codes for types of information used in business documents. The data dictionary reduces vast amounts of information to two-digit codes (called *data elements*), and therefore eliminates the need for descriptive information in an electronic document.

ANSI X12.1-1986	Purchase Order Transaction Set (850)
ANSI X12.2-1986	Invoice Transaction Set (810)
*ANSI X12.3-1986	Data Element Dictionary
ANSI X12.4-1983	Remittance/Payment Advice Transaction Set (820)
*ANSI X12.6-1986	Application Control Structure
ANSI X12.7-1986	Request for Quotation Transaction Set (840)
ANSI X 12.8-1986	Response to Request for Quotation Transaction Set (843)
ANSI X12.9-1986	Purchase Order Acknowledgement Transaction Set (855)
ANSI X12.12-1986	Receiving Advice Transaction Set (861)
ANSI X12.13-1986	Price/Sales Catalog Transaction Set (832)
ANSI X12.14-1986	Planning Schedule with Release Capability Transaction Set (830)
ANSI X12.15-1986	Purchase Order Change Request Transaction Set (860)
ANSI X12.16-1986	Purchase order Change Request Acknowledgement Transaction Set (865)
*ANSI X12.20-1986	Functional Acknowledgement (997)
*ANSI X12.22-1986	Data Segment Directory

Figure 3. American national standards for electronic business data

The *data segment dictionary* provides the definition and formats for data segments. These data segments consist of a precise sequence of data elements, separated by delimiters.

The *transmission control standards* define the formats for the information required to interchange data. Defined within the transmission control standards are data element delimiters, transaction set separators, and transmission *envelope* formats. Figure 4 [Ref. 2: p. 67] illustrates a typical paper invoice. Within the electronic invoice, as with each transaction set, there are three general areas that relate directly to the format of the printed document :

- **The header area** contains preliminary information that pertains to the entire document, such as the date, company name, address, p.o. number, number, and so on.
- **The line item area** encompasses the actual business transaction and includes such information as quantities, descriptions and prices. Again, in EDI, each line is called a *data segment,* and each item within the segment becomes a *data element.*
- **The summary area** contains control information and other data that relate to the total transaction.

To generate electronic documents, the information contained in the invoice is replaced with the appropriate X12 codes, as compiled in the data dictionary. Data elements are separated by asterisks (*); data segments are separated by "N/L" indicators. A line-by-line comparison of the X12 invoice and the paper invoice of Figure 5 [Ref. 4: p. 53] appears in Figure 6 [Ref. 4: p. 54].

In Electronic Data Interchange, each line is called a segment and each item within the segment becomes an element.

The benefits derived from the use of a standard format for a specific transaction set are many fold. In one surveyed organization, it was estimated that more than 400 different purchase order formats were being

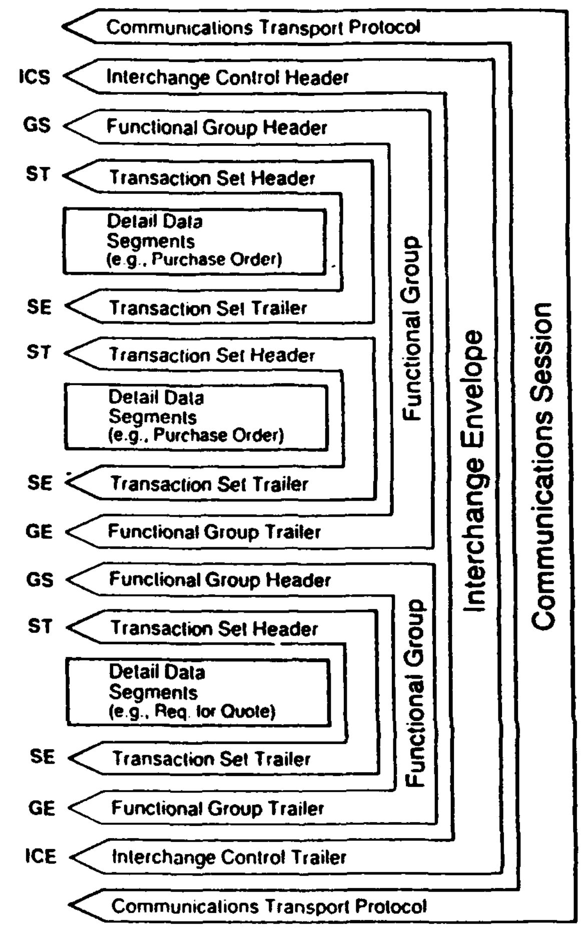

Figure 4. ANSI X12 interchange structure

received weekly. The potential EDI user should recognize the important benefits that result from the use of a single, standard format purchase order for all buying and selling activities. Even the company which desides not to transmit business data electronically could benefit from the use of standardized transactions. This simplification in transacting data

Purchase Order Date: 04/23/84 Page 1 of 1

5KK3-05530
This Number Must Appear on all Boxes, Packages, Shipping Documents & Invoices.

To: Selling Party 400061
123 E. West St.
Anytown, USA 99999

Buyer Contact
Joan Buyes

From: Buying Party 162
444 W. East Ave.
Downtown, USA 99999

Ship: Ship To Party 1100
Receiving Dock
100 Main St.
Downtown, USA 99999

Ship	FOB	Freight Allowance	Terms	Ship Date	Due Date
Truck	Mill	Less C/L FA	2/20LCC	05/13/84	05/15/84

Line No.	Your Item No.	Our Item No.	Item Description	Unit Price	Quantity	UOM	Item Due Date
1	20784	1147560	23x35 810C Shasta	56.75	16	Ctn	05/15/84
			Gl Bk Whte		16	Ctn	05/22/84
					16	Ctn	05/29/84
2	14096	1124486	23x35 880 Shasta	59.50	16	Ctn	
			Suede Bk Wh				
3	51193	1107820	23/35 Offset Opaq	46.00	16	Ctn	
			Vellum				

Figure 5. Original purchase order

is supported by widespread acceptance of ANSI X12 business data interchange standards.

Figure 7 further illustrates the ANSI transaction development process leading to standards publication. A number of project teams and subcommittees are involved. Firms without participation in the standard

Format for EBDI

ST*850*8400 N/L

Related Purchase Order Section

Purchase Order

Format for EBDI	Related Purchase Order Section
BEG*00*SA*5KK3-05530***840423 N/L	Date: 04/23/84 — 5KK3-05530 This Number Must Appear on all Boxes, Packages, Shipping Documents & Invoices.
N1*SE*92*400061 N/L	To: Selling Party 400061, 123 E. West St, Anytown, USA 99999
N1*BY**91*162 N/L PEP*SD*Joan Buyes N/L N1*ST**91*1100 N/L	From: Buying Party 162, 444 W. East Ave, Downtown, USA 99999 Buyer Contact Joan Buyes
ITD*01*03*2**20 N/L SHH*SD*010*840513 N/L SHH*DD*002*840515 N/L FOB*PP*M1*Less C/L FA N/L TD2*O*E N/L	Ship: Ship To Party 1100, Receiving Dock, 100 Main St., Downtown, USA 99999
PO1*1*48*CT*56.75*QT*IN*1147560*VN*20784 N/L SCH*16*CT****002*840515 N/L	Terms: 2/20LCC
SCH*16*CT****002*840522 N/L SCH*16*CT****002*840529 N/L	Ship Date: 05/13/84 — Due Date: 05/15/84
PO1*2*16*CT*59.5*QT*IN*1124486*VN*14096 N/L PO1*3*16*CT*46*QT*IN*1107820*VN*51193 N/L	FOB: Mill — Freight Allowance: Less C/L FA
CTT*3*80 N/L SE*19*8400 N/L	Ship: Truck

Line No.	Your Item No.	Our Item No.	Item Description	Unit Price	Quantity	UOM	Item Due Date
1	20784	1147560	23x35 8100 Shasta	56.75	16	Ctn	05/15/84
			Gl Bk White		16	Ctn	05/22/84
					16	Ctn	05/29/84
2	14096	1124486	23x35 880 Shasta	59.50	16	Ctn	
			Suede Bk Wh				
3	51193	1107820	23/35 Offset Opaq	46.00	16	Ctn	
			Vellum				

Figure 6. Translation of purchase order

setting process should familiarize themselves with the process and consider some form of participation [Ref. 4: p. 52].

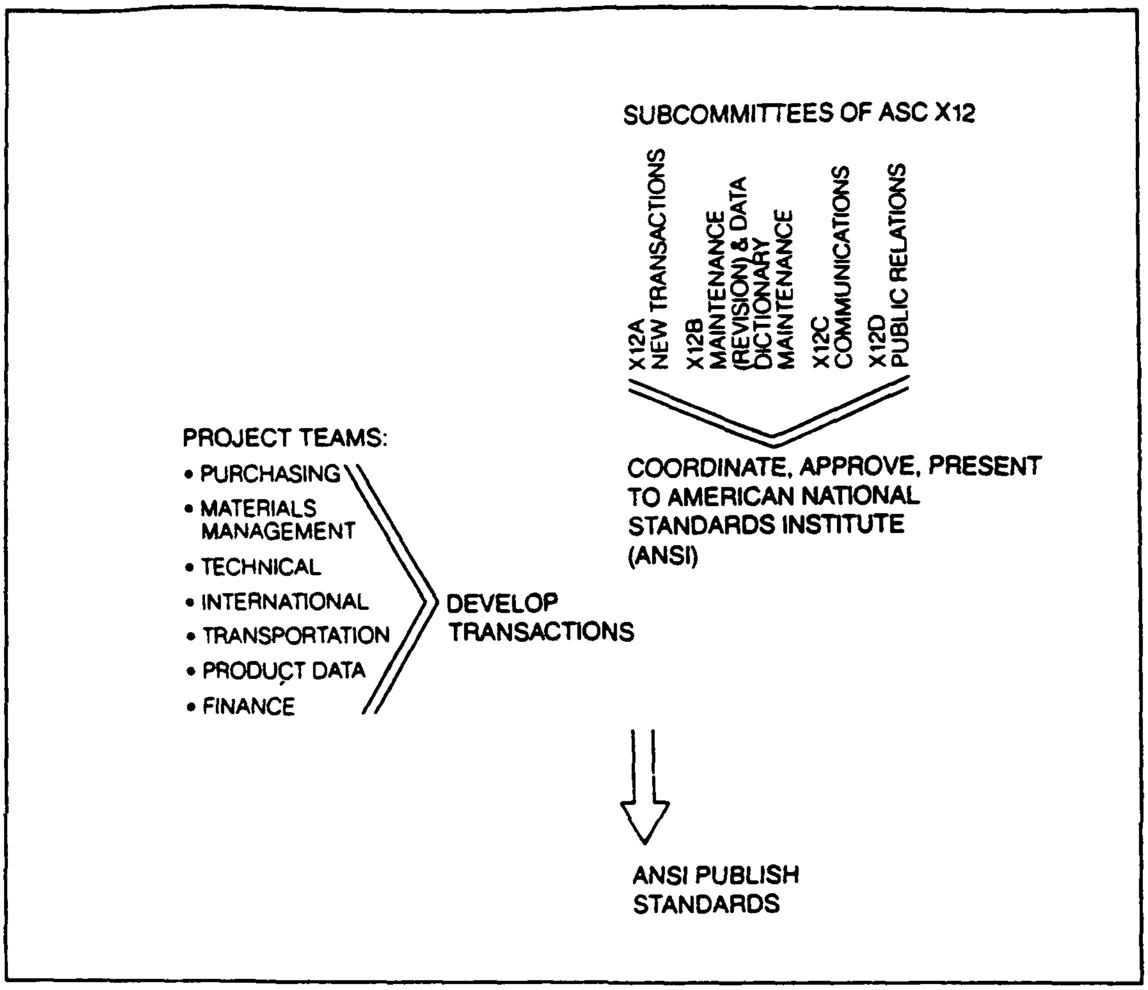

Figure 7. Transaction development process

C. EDIFACT

Until relatively recently, most UK and European EDI users have based their standards on the United Nations Trade Data Interchange (UNTDI) syntax (United Nations Economic Commission for Europe: Guideline for Trade Data Interchange). This system is highly flexible and provides guidelines on syntax (character sets and transmission formatting rules) and on segment and message construction. There is also an associated directory of data elements, data elements being the basic components of an EDI message [Ref. 3: p. 60].

It should be noted that recent initiatives have been taking place to bridge the differences which exist between the UNTDI syntax and the American National Standards Institute's equivalent system known as ANSI X12. The objective is to allow the building of EDI standards which will be valid for trade across international boundaries. The project began life as a joint effort between European and American EDI experts, and was christened Joint Electronic Data Interchange (JEDI). Following the agreements reached by the JEDI representives on principles and syntax, the project has received widespread support from the many countries and user communities and, importantly, from the ECE (Economic Commission for Europe). It is known as Electronic Data Interchange for Administration, Commerce and Transport (EDIFACT).

The new EDIFACT EDI syntax has alway been accepted as a full international standard: ISO 9735. The EDIFACT syntax is not greatly dissimilar from UNTDI, but there are some important differences which also have an impact on the method of standard message design. International standard messages (UNSMs) are now being developed as part of the EDIFACT project, which is coordinated by the EDIFACT board and steering committee. Advanced drafts of the invoice and order files are already available. Other files are being developed as quickly as possible in order of perceived priority. UNSMs are being based on the United Nations data element directory with new elements being created as necessary. They also use the concept of qualifiers, well established in ANSI X12 standards. Qualifiers are codes used to confer a specific function or identify on a generic data element or segment. Further details on the availability of UNSMs and on the EDIFACT project in general are obtainable from the UK Simplification of International Trade Procedures Board (SITPRO). The EDIFACT standards or syntax will not immediately or indeed ever supercede or outmode standards based on UNTDI, which have a large, established and successful user base. Nevertheless, there is growing support in principle for the evolution toward EDIFACT standards as the solution for EDI across national boundaries [Ref. 5: p. 31].

D. CALS

1. Background

We have witnessed a rapid growth in technology and in product complexity, and with that growth has come an increasing volume of product information in recent years. As the systems we develop become more complex, the teams needed to design and develop these systems become more specialized. Sophisticated documentation and information exchange are necessary to hold an organized development effort together. Governments, contractors, subcontractors, and developments within companies all need to share information rapidly and effectively. Whenever information is unusable or needs to be converted to another form or retyped into a different computer system, there is wasted effort and delay in the development cycle, which costs time and money.

The United States Department of Defense (DoD) has recognized the need to increase the efficiency and productivity of development efforts and the quality of final products. The DoD plans to achieve this by modernizing the information systems that support the life cycle of defense weapon systems. By specifying the form and structure of weapon-systems data bases, the DoD is promoting more effective, accurate, and efficient information exchange among DoD agencies, military services, and industry partners. The effort was launched in 1985 as a DoD task force project through a directive from the Deputy Secretary of Defense, William H. Taft. Known as the Computer-aided Acquisition and Logistics Support (CALS) initiative, it has become a committed direction for all U.S. weapon systems. The product of this initiative is a set of military standards and specifications that define formats, structures, and protocols for the information that is exchanged [Ref. 6: p. 4-1].

While the DoD and its industry partners are designing and implementing CALS systems, other government agencies, manufactures of *high-tech* products, and governments worldwide, particularly Canada and European countries, are becoming aware of the benefits of such a system. Some of these organizations have begun to adopt the CALS standards and specifications, in whole or in part, as the basis of their information systems. Thus, what started as a DoD initiative is becoming a global model for information systems supporting complex technical products of the future.

The initial phase of CALS standardizes the exchange of textual and graphic documentation for both printed copy and digitally communicated information. The long-term goal of the CALS initiative is a totally integrated weapon-systems data base in which all information about a weapon system resides. Rather than exchanging information on various media, such as paper or magnetic tape, authorized users will access a data base to get the information they require. Thus, users who need accurate, up-to-date information can get it quickly and efficiently. The immediate and long-term benefits of a CALS system are substantial, including:

- Reduction in the product development cycle
- Reduction in development and service costs
- Increase in the accuracy of product information
- Improvement in the integrity and readiness of the weapon system. [Ref. 7: p. 16]

2. What is CALS?

Computer-aided Acquistition and Logistics (CALS) is a strategy that the DoD and its industry partners are using to enable and accelerate the integration of the digital technical information that is associated with the acquisition, design, manufacture, and support of a weapon system. CALS provides for a transition from current, paper-intensive processes to the efficient use of digital information technology. The first phase of the CALS initiative focuses on technical publications and the information used to create them. Traditionally, the process of acquiring an information-processing system has been difficult and expensive. Each weapon system has its own requirements; therefore, building the appropriate information-processing system means continually reevaluating, upgrading, and reconfiguring the existing equipment and software, and possibly migrating to an entirely new system. The CALS approach to this challenge is to put all the information about the product, from design specification to engineering drawings to project management data to technical manuals, in an integrated data base. If all the information is in one data base in standard formats, the need to covert or reformat the information is greatly reduced. Those who need to use the information or contribute to the data base simply access the data base through defined query or retrieval interfaces. A central data base helps users more easily access information, in essence bringing the information to the users. It's their responsibility to use a system that can communicate with the data base and accept and deliver information in the proper format.

An integrated data base is the solution for which the CALS community is striving. However, there are a number of hurdles to overcome first, one of which is standardization of information and data formats. Therefore, the immediate goal is to improve the process of exchanging information among different computing systems. In the initial phase of CALS the DoD, working with industry steering groups, has defined several standards and specifications. Drawing from existing international standards, the CALS committees have defined the acceptable formats for textual, graphic, image, and engineering information. Figure 8 [Ref. 7: p. 14] provides a brief summary of the primary CALS standards and specification that the DoD has defined.

By standardizing the format of information, the DoD can be sure that, regardless of what computer system the information comes from, other computer systems can process it. It's up to everyone involved to use a system that can accept, process, structure, and deliver the information in a format that conforms to the CALS standards and specifications.

3. Relationship between EDI and CALS

The relationship between EDI and CALS can be summarized by the following positions taken by DoD and NIST.

- December 1988, MIL-HDBK-59; CALS will use EDI transaction sets for exchanging technical information.
- March 1989, DoD recommendation are link CALS data and EDI data into one protocol. As proposed by automotive industry action group (AIAG) and DOD memo stating that a "common technical approach" be taken to ensure "complementary implementation" of CALS and EDI.
- Sept 1989, Dept of commerce (NIST) published "Transmission of CALS 1840A technical data through the use of X12 EDI transaction set 841".
- EDI transaction set 841, Specifications/Technical Information, has been specified in ANSI X12.51 by its Product Data Subcommittee. It provides for the exchange of complete or partial specifications or technical information related to products and services [Ref. 7: p. 22].

Standard or specification	Description
Military Standard MIL-STD-1840A: Automated Interchange of Technical Information	An "umbrella" standard that describes all of the requirements for delivering CALS documents. MIL-STD-1840A refers to the military specifications listed below. It also describes how information is to be loaded onto magnetic tape for delivery.
Military Specification MIL-M-38784B: Manuals, Technical: General Style and Format Requirements	Describes the general requirements for military documentation, from content and style to page-layout specifications.
Military Specification MIL-D-28000: Digital Representation for Communication of Product Data: IGES Application Subsets	Describes the format for graphics files containing engineering information.
Military Specification MIL-M-28001 and MIL-M-28001A: Markup Requirements and General Style Specification for Electronic Printed Output and Exchange of Text	Describes the format for text files. Basically, MIL-M-28001 defines Standard Generalized Markup Language (SGML) *document type definitions* (DTD) for CALS documents. A later section of this book describes how CALS uses SGML.
MIL-R-28002: Raster Graphics Representation in Binary Format. Requirements for	Describes the format for raster (dot-oriented) graphics files.
MIL-D-28003: Digital Representation for Communication of Illustration Data: CGM Application Profile	Describes the format for vector (line-oriented) graphics files.

Figure 8. CALS standards and specification

III. ANALYSIS OF TRANSACTION AND DATA MAPPING

A. TRANSACTION AND DATA FLOW

The introduction of Electronic Data Interchange can impact the documents traditionally used to transmit necessary information. EDI can eliminate nearly all external paper. This section has two major objectives. The first is to document the flow of paper in a traditional manual purchasing and material management system. The second objective of this section is to explain how the paper flow may change as a firm evolves from a manual to a computerized purchasing system with EDI.

In a manual purchasing system for a typical purchasing department, a paper flow is established to support its routine, day-to-day activity, and this flow provides information to a multitude of different individuals located in several functional departments. This paper flow has developed over time into a series of procedures that meet four basis concepts:

- The flow of paper permits the efficient use of purchasing resources in conducting the routine activities of the department. Most paperwork is done by clerks instead of managers.
- The flow of paper provides needed information to the various department that are affected by the placement of an order, e.g., manufacturing control, inventory control, receiveing, accounting, etc.
- The standard flow of documentation is clearly defined. The reason for this standardization of procedures is so that the multitude of

clerks supporting the system can process the documentation with minimum effort and uncertainty.

- The flow of documentation permits managerial discretion. When conditions arise that are not routine or normal, responsible managers are informed about the condition. These managers can take corrective action before any problem arises. [Ref. 4: p.37]

The flow of paper in a manual purchasing system such as the one illustrated in Figure 9 [Ref. 4: p.39] accomplishes these conditions. The normal paper flow shown in Figure 9 is quite complex because of the continuous flow and enormous quantitites of paper generated and stored. Unless these documents are organized in a systematic manner, much of the information contained in these documents would be useless to purchasing and other departments within the firm. Figure 10 [Ref. 4: p.40] shows a simplified inter-firm transfer of documents on a manual basis.

In a computerized purchasing system, EDI has been defined as the exchange of business information from one firm to another in machine readable form. EDI was developed to eliminate the external documentation between a supplier and buyer, not the internal paper. A computerized purchasing information system with or without EDI is needed to eliminate much of the internal documentation. Many firms have computerized purchasing information systems without EDI that are quite sophisticated.

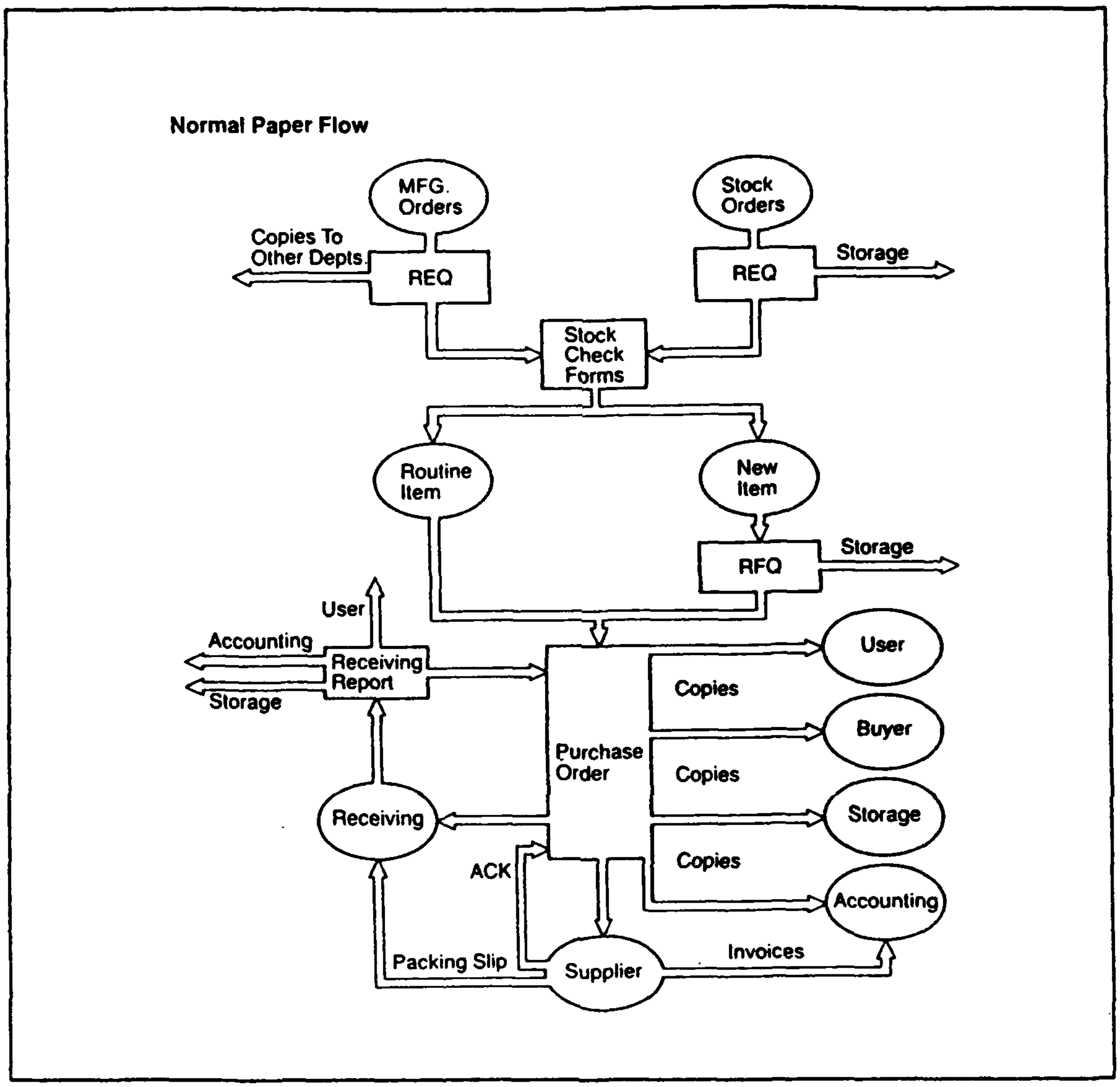

Figure 9. Manual system

Such information systems have various modules for on-line purchase order, purchase order change notice, receiving inspection, and inquiry. They also have interfaces with accounts payable and requirements planning. By and large, these sophisticated purchasing information systems

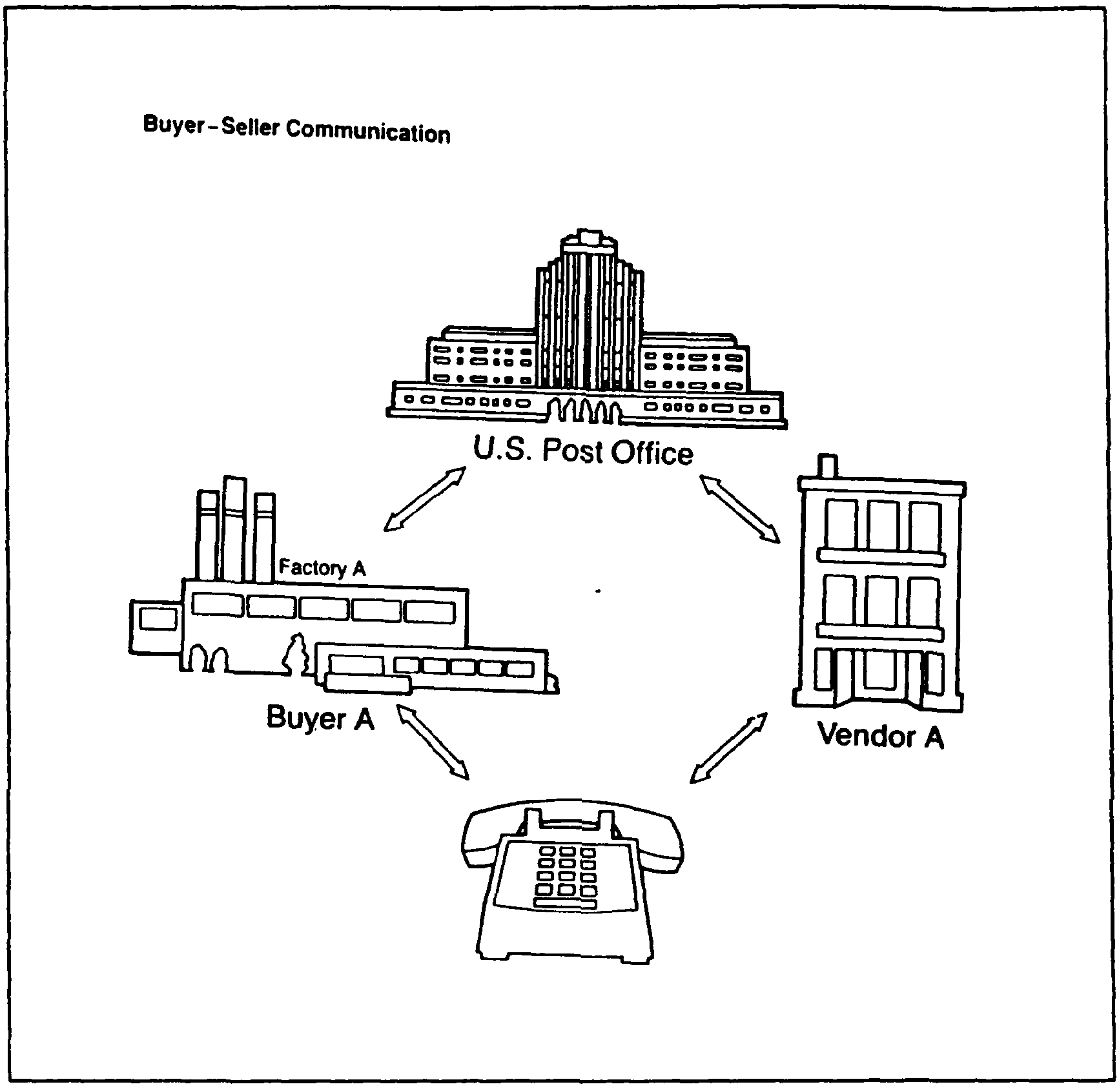

Figure 10. Manual system

have eliminated much of the internal paper generation through intelligent design and without the use of EDI [Ref. 4: p. 40].

EDI involves external communication with suppliers. Figure 11 [Ref. 4: p. 42] illustrates the communications between buyer and seller for a

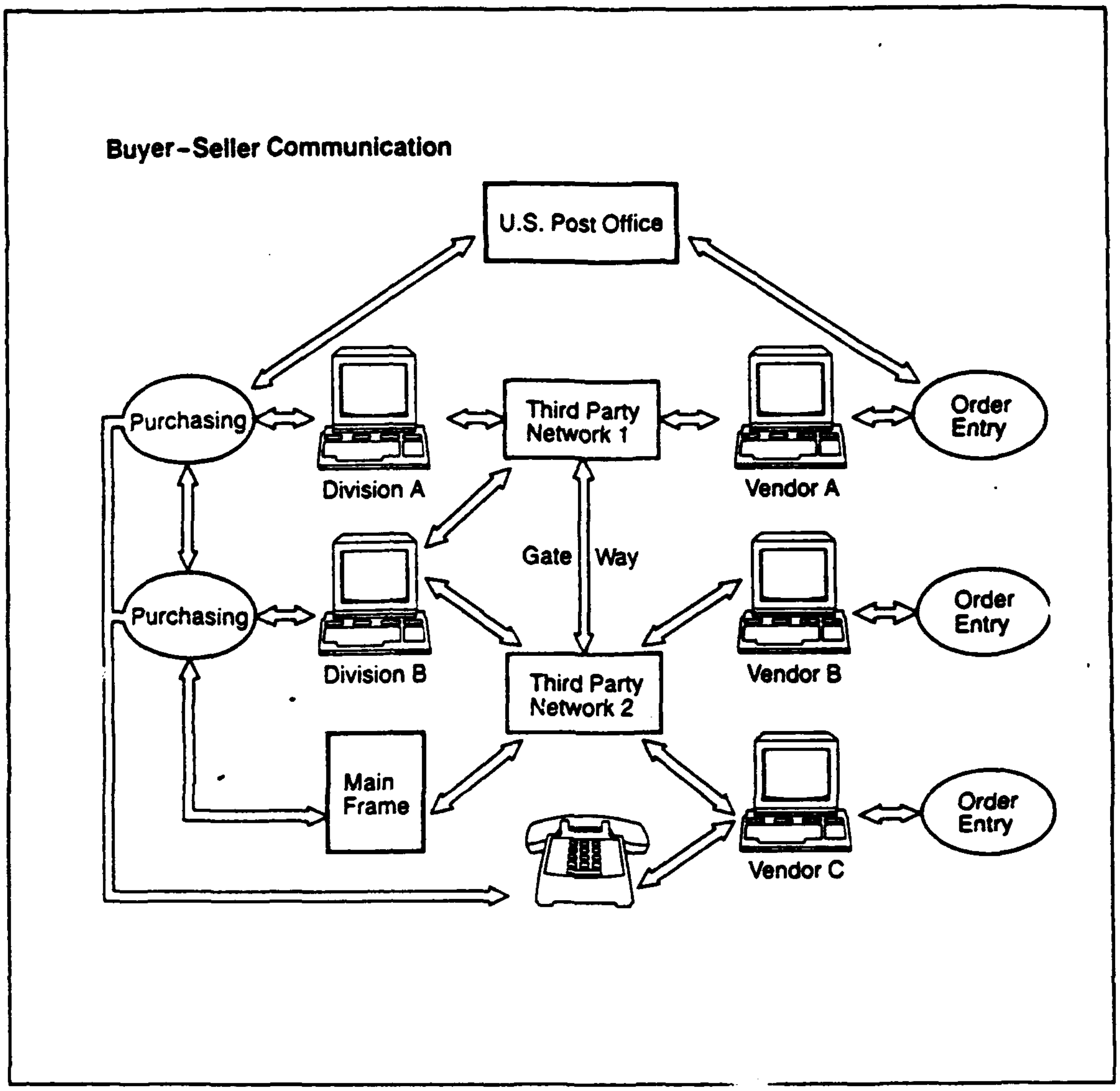

Figure 11. EDI system

fairly sophisticated EDI system. The elimination of paper requires a well planned sequence of events. Even though the EDI system is electronically sophisticated, some purchase orders, acknowledgement, requests for quote, etc., for certain purchase items may still be sent by mail. It is also desirable to maintain a direct communication channel between the buying firm and one or more suppliers, even though a third-party network is in operation. This direct communication can be by means of computer, telephone, and/or mail.[1] In sum, an integrated purchasing/EDI system, where both digital and manual methods of communication are available, is a very desirable type of system configuration. An integrated purchasing/EDI system such as the one pictured in Figure 11 can eliminate most of the external physical documentation and still maintain the flexibility critical to any purchasing system.

Several issues arise for a firm operating in an EDI environment. One key issue concerns the storage of electronically transmitted purchase documents. A decision concerning an appropriate storage mechanism, e.g., magnetic tape, hard disk, floppy disk, microfiche, etc., must be made by all firms involved in the EDI system [Ref. 3: p. 38].

Another issue concerns the operation of a parallel purchasing system during the initial phase of EDI implementation. Both hard-copy of the purchase order and the EDI transaction would be sent to suppliers. Parallel systems are a necessity, but frequently short lived. For one firm, the

1 Multiple third-party networks including a gateway may be used to support EDI. From information gathered in a survey, it seems probable that the use of third-party networks will increase significantly in the future.

parallel system lasted only 3-6 weeks and was discontinued as soon as each each supplier gained confidence in the EDI system [Ref. 3: p. 42].

A third issue raised by the implementation of an EDI system concerns job content. The job of the typical purchasing professional in the EDI environment can change significantly. Purchasing personnel will spend a much smaller percentage of their time *firefighting* and a larger percentage of their time planning purchases. The change in work flow for buyers should be carefally managed. Buyers should continue to review orders. After the paper begins to disappear, they should print logs of purchase orders and change notices placed during any day. They also have to keep a purchase order number as a control number for reference purposes with vendors. It is a good policy to eliminate only one physical document type at a time and initially keep the set of vendors small [Ref. 3: p. 43].

The implementation of EDI can create a more effective receiving function through the better scheduling of receipts. As the paper disappears, the receiving function will be forced into a closer integration with the ordering function. The information concerning order status and shipping which at one time was available primarily to purchasing can now be used by the receiving function for a more efficient operation. With the advent of more frequent orders and a shorter purchasing cycle time, efficient receiving operation is important to the proper functioning of the entire procurement and manufacturing system [Ref. 3: p. 45].

B. DATA MAPPING

Data mapping extends the EDI process by using the values received as though they had been entered into the user's information system locally [Ref. 8: p. 2]. A purchase order received electronically is automatically entered into the system as though it had been given verbally to an order clerk and hand-entered. A shipping notice is received providing location information on an inbound shipment. The values are automatically stored in the interactive database which allows users to access the information at any time. On the transmitting side, an invoice is developed from the accounts receivable software and transmitted to the recipient without human intervention at any step of the process. The *computer-to-computer* portion of the process (Figure 12) [Ref. 8: p. 2] is what we often mean when we say we are *doing EDI*. The answer is where the efficiencies lie. Transmitting a purchase order electronically will assuredly save time and promote greater accuracy, but only to the point where the purchase order appears as output of the receiving company's corporate information system. The computer system then actually processes the purchase order, fully realizing the efficiencies. Data mapping is the process that will ac-

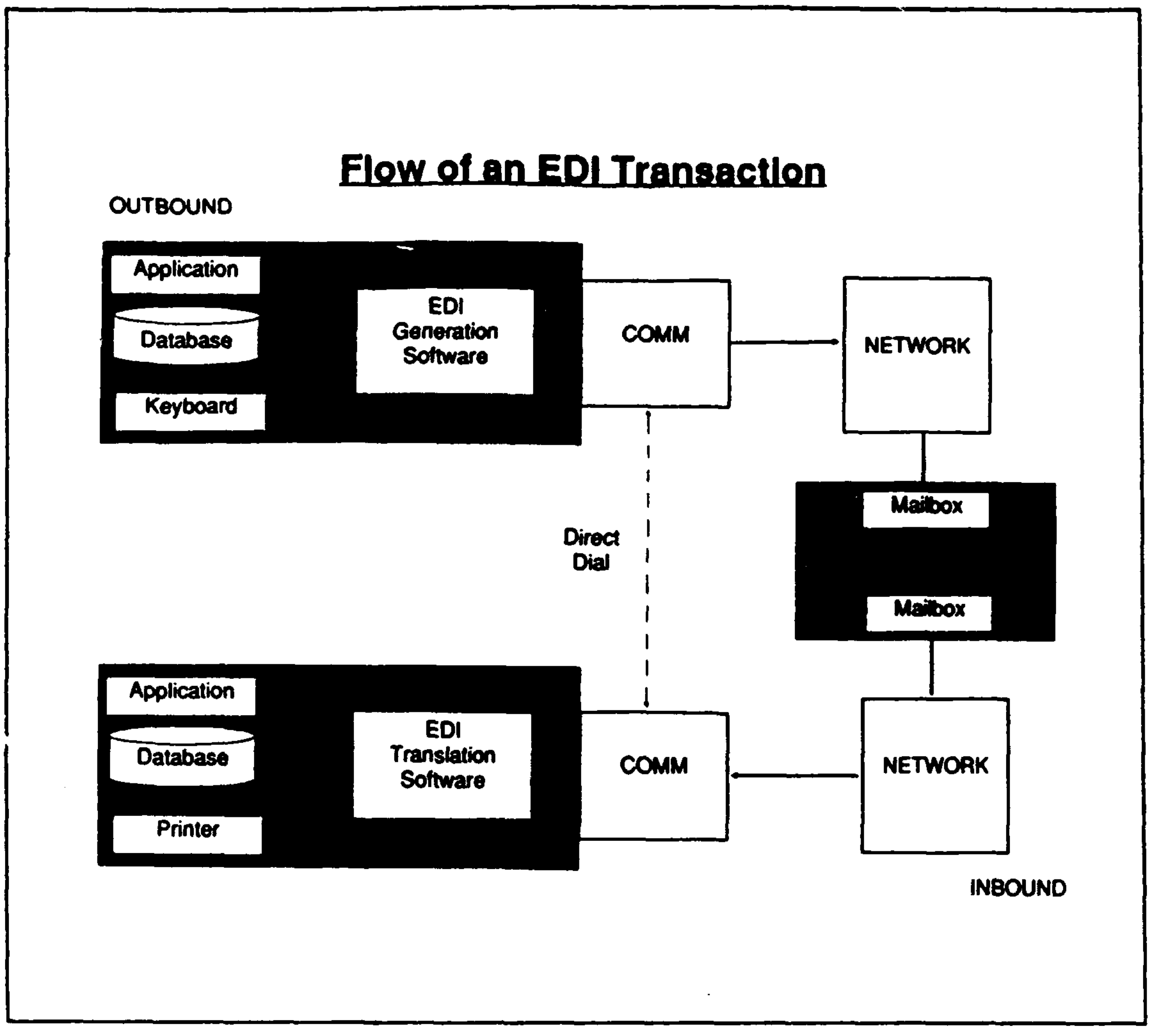

Figure 12. Flow diagram of computer-to-computer EDI

complish this extra step. By taking the values produced by the translation software and automatically integrating these values into procedure calls, database assignments, or some combination of these, the most inefficient part of the system can be eliminated. We develop a conceptual description of data mapping under the following five scenarios [Ref. 8: p. 4].

1. The paper system

A paper system (Figure 13) [Ref. 8: p. 8] does not carry the data beyond the translation process. On the receiving side, EDI transmissions are translated and pointed out for further action. The *further action* may be the use of these values to enter data into an automated system that is not yet integrated with EDI software. It may be the begining of a totally manual process. On the transmitting side, data is entered into the EDI translation software via a keyboard. Most software packages provide the user with a great deal of assistance in this process via user-friendly input screens, template generation, and code selection capabilities. Paper EDI systems are used most often by small companies who are not prepared to fully integrate EDI. In many cases they have been *persuaded* by a major trading partner to begin doing business via EDI. They may not be able to cost justify the development of a fully integrated EDI system. Paper systems are sometimes used by larger companies as part of a pilot effort or as a means for getting into EDI quickly with the intent of integrating later. Since a paper system is a complete system, it is a logical step in the *build-a-little-test-a-little* process.

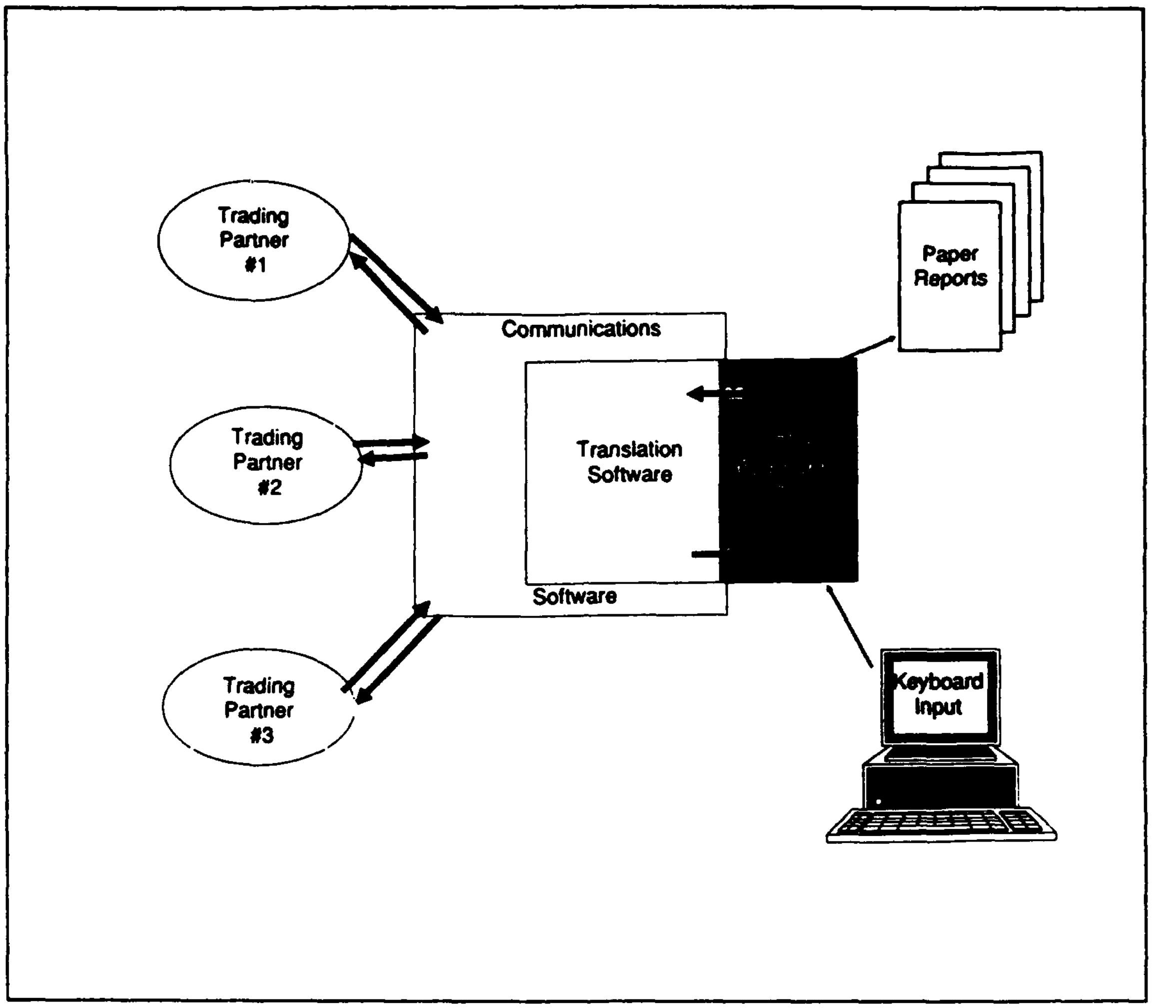

Figure 13. Paper EDI system

2. Integrating with the existing database

This scenario consists of the most basic integration mode, that of simply interfacing the EDI translation software with an existing database. The implication of this type of activity is that we will be dealing strictly with static data values. The translation software uses an intermediate flat

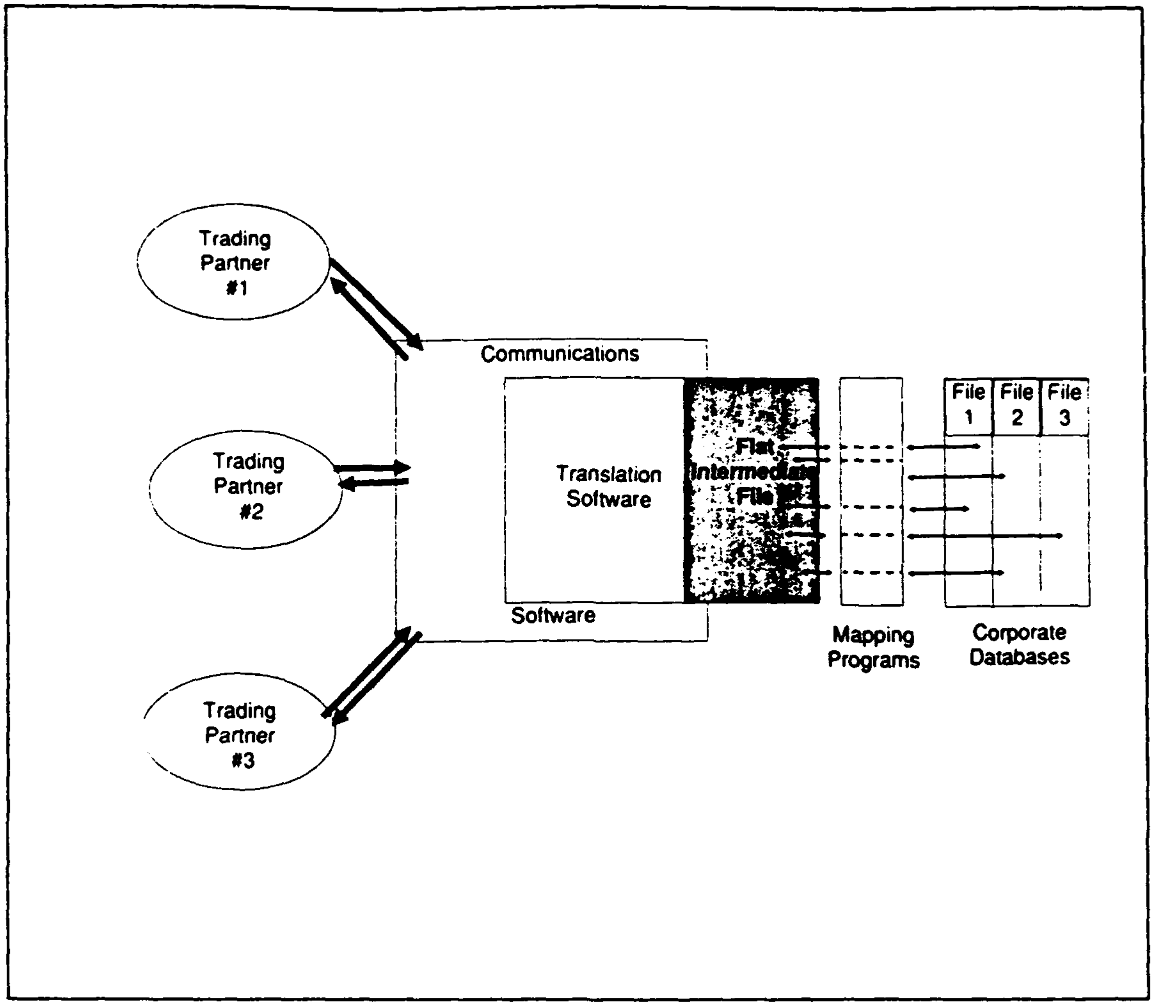

Figure 14. Integrating EDI with existing corporate database

file to pre-stage raw data for translation into EDI transaction sets and as output when interpreting EDI transaction sets. The integration involved is the process of programatically mapping values between the flat file and the appropriate locations in the corporate data base (Figure 14) [Ref. 8: p. 10]. This involves an analysis of the corporate use of each element in each transaction set to determine what values will be transported to what database locations. This programming process is the origin of the term *data mapping* which is frequently applied to all of the aspects of application integration described in this section. We shall use the term *database mapping* to describe the process of mapping only static data, that which will not be used immediately but will be stored for future use. The more generic *data mapping* will be used to include application integration, the immediate employment of data values as part of a process or procedure call where the data values are used as parameters.

3. Integrating with existing applications/processes

This scenario is similar to that of data mapping except that instead of mapping raw data values from an intermediate file to a database, data are extracted and mapped into an existing procedure call which will than be applied in its normal manner to the corporate system (Figure 15) [Ref. 8: p. 11]. An example of this would be incorporating EDI into an existing system that allows the execution of computerized purchase orders. The integration of EDI would permit automatic execution of purchase orders received via EDI transaction sets. Note that, in mapping to a database, almost any type of transaction set can be received and mapped. The difference in the scenario being described is that only those transaction sets

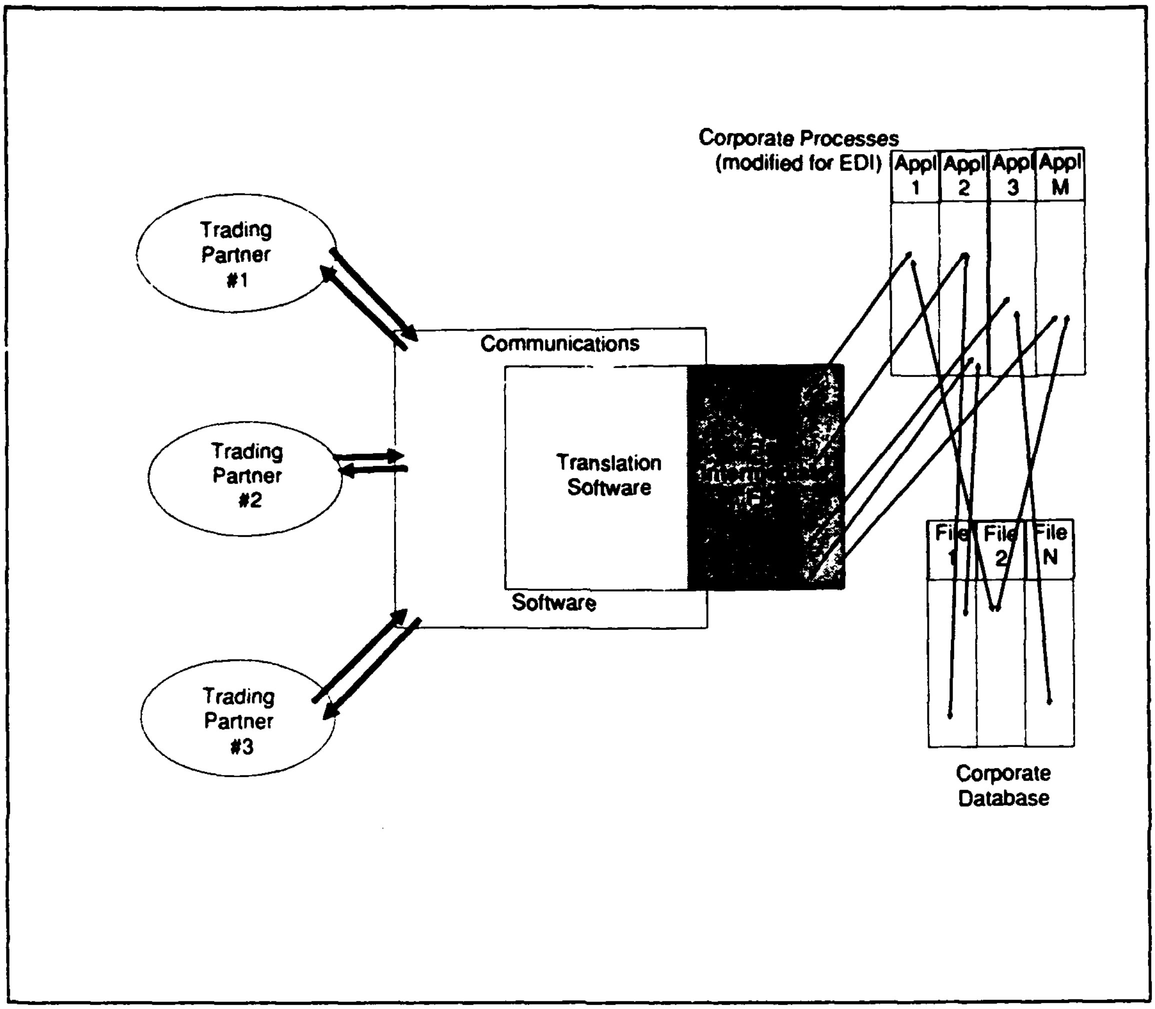

Figure 15. Integrating EDI with existing corporate processes

can be integrated for which an automated corporate process (e.g., placing or receiving an order, sending or receiving an invoice) already exists.

4. Developing new applications/processes based on EDI

In this scenario, the EDI user is interfaced with developing systems or subsystems for EDI transaction sets which do not correspond to

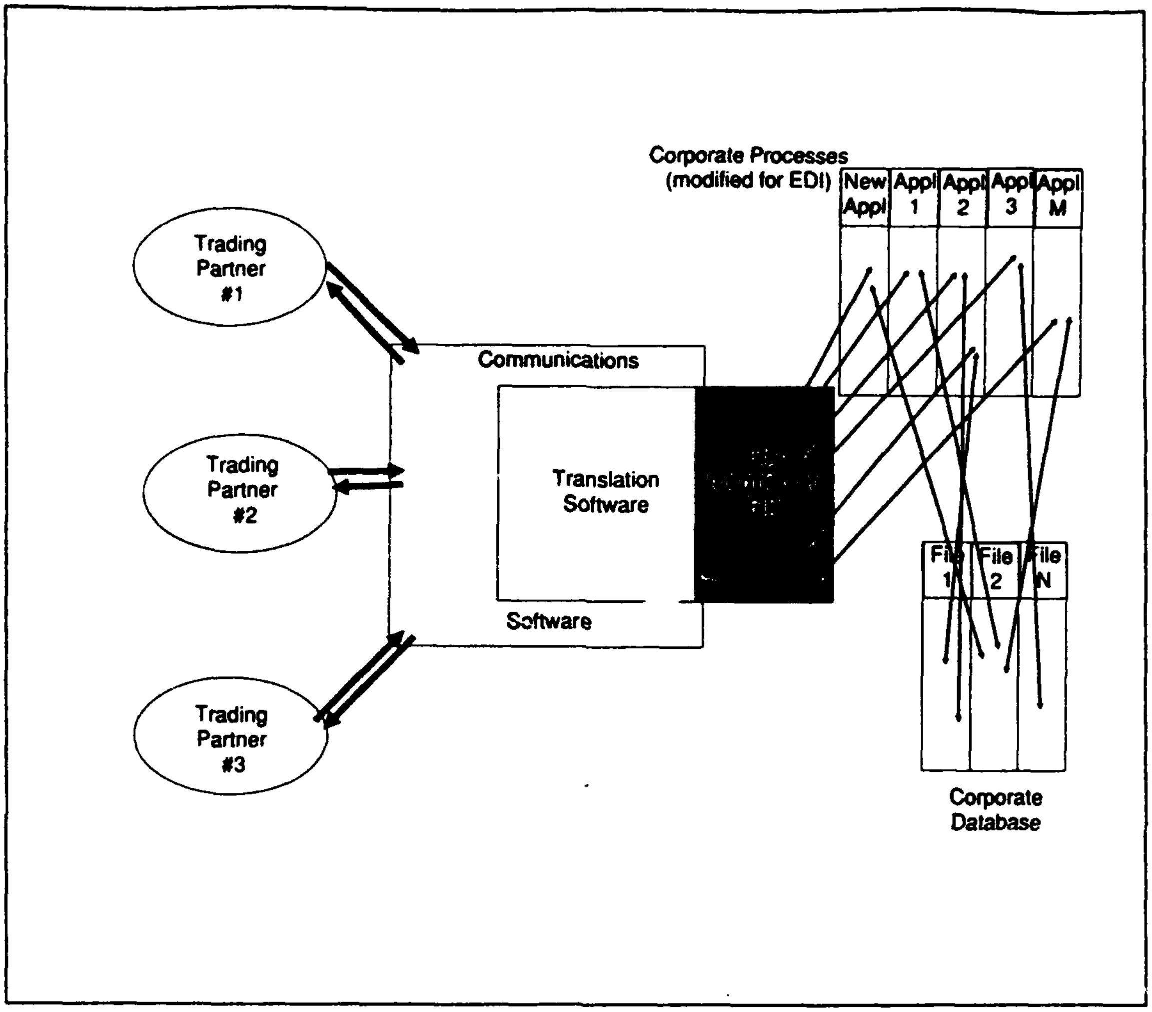

Figure 16. Developing new processes based on EDI

processes currently being used in the corporate system. This type of approach presupposes either a new type of business being created by the introduction of EDI or the recognition of the need for new internal processes due to the advent of EDI. In either case, instead of applying the data to existing processes as described in the preceding subsection, new corporate processes will be developed which include integrated EDI as part of the application. These would, in turn, be integrated into the overall corporate information system (Figure 16) [Ref. 8: p. 13].

5. Fully integrated application/EDI system development

The final scenario which will be discussed in this section is that of including EDI integration in the design of a new corporate business data processing system (Figure 17) [Ref. 8: p. 15]. Many new design considerations, in addition to those normally experienced in a system development process, will be encountered. Among these are the selection of translation software. Selecting or developing software that can be coupled directly with applications modules could eliminate or reduce the need for interface files. Proceeding with the development in this manner could produce a very efficient, tight coupling between the modules of the system and the translation software. These and other complex decisions are involved in the pursuit of this type of development.

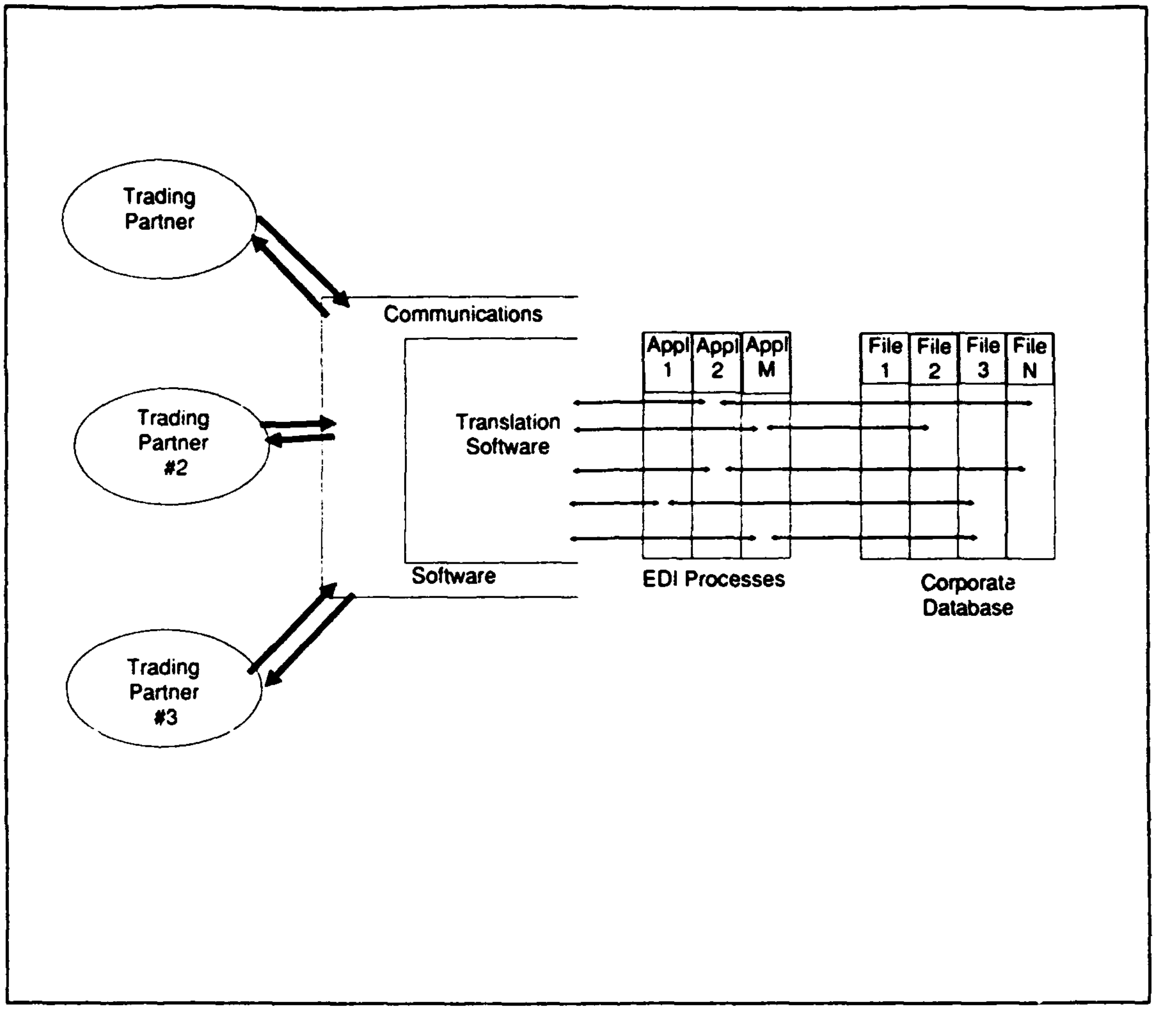

Figure 17. Fully integrated application/EDI system

IV. HARDWARE AND SOFTWARE REQUIREMENTS

A. HARDWARE REQUIREMENTS

There is actually no such thing as unique *EDI hardware.* EDI software is available for mainframes, minicomputers, and microcomputers. All it takes to do EDI is a computer of some type, a communications modem, and software. The most common hardware and software combinations used to perform EDI are shown in Figure 18 [Ref. 9: p. 90]. As shown in the Figure, three basic options exist: mainframe only, microcomputer only, and microcomputer as a front-end processor to a mainframe.

The minimum microcomputer configuration to implement an EDI system consists of: [Ref. 4: p. 65]

Computer

- Processor - 16-bit minimum
- Memory-256kb, expandable
- Real-time clock

Screen Display

- 24 line X 80 character

Disk Storage

- 2 dual-sided floppy-360k
- Optional : Hard Disk 10 MB

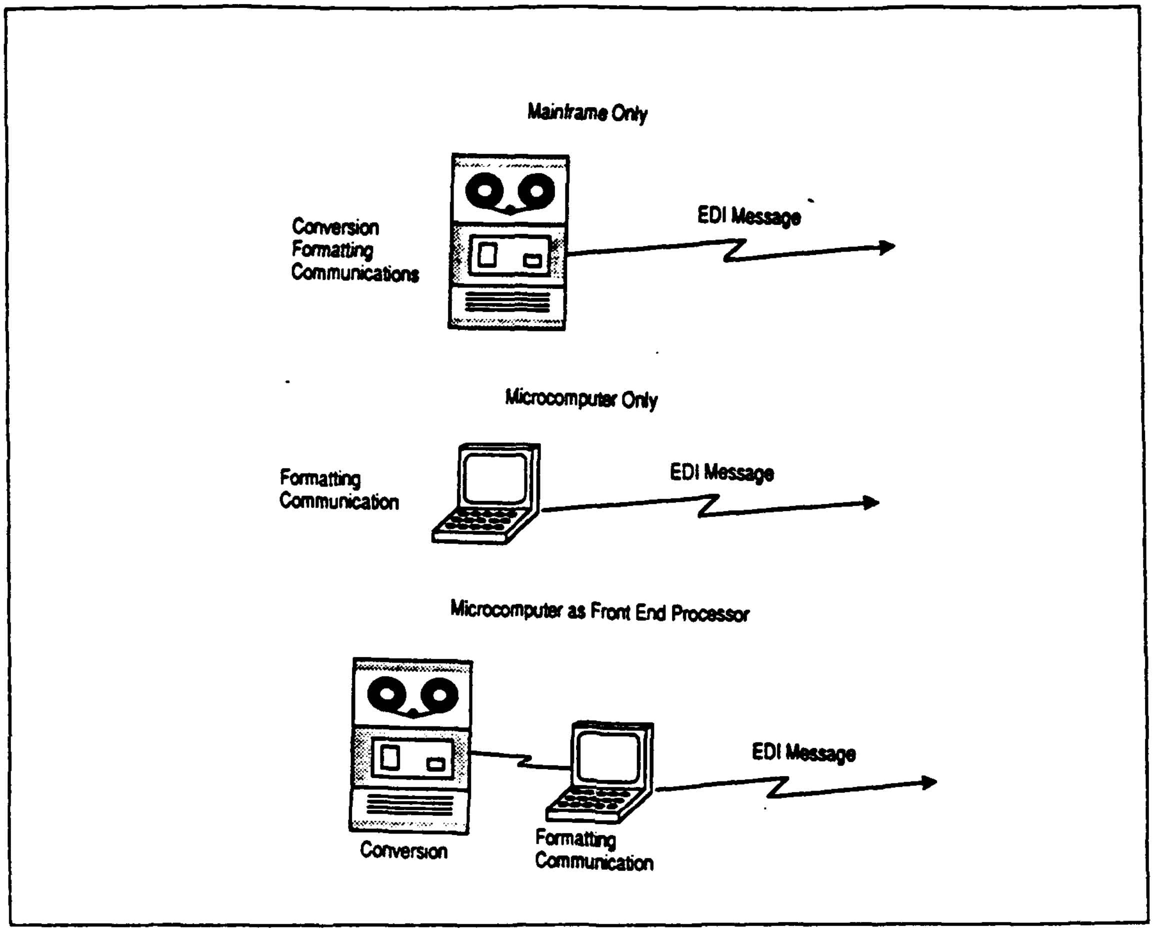

Figure 18. **Software/hardware options.**

Communications

- Hardware - RS232 serial interface port
- Modem - 1200 to 9600 Baud, Bell 201 C and 208 B compatible for 2780/3780 emulation, bisynchronous
- Communication lines - Bell 208 B or equivalent
- Software - capable of communication with partner's PC or mainframe

Operating System

- MS-DOS, Unix, or UNIX compatible

Programming Language

- Varies with choice of third parties and industry
- Recommend ANSI X12

Printer

- Dot matrix, 160 character/sec, 80 column or 136 column
- parallel or serial interface

If we include the third-party support as an option, there are four different system approaches regarding hardware platform for EDI, as illustrated in Figure 19:

- PC-based configuration
- mainframe based configuration
- PC-to-mainframe configuration
- third-party support.

The advantages and disadvantages and the costs of these four approaches are summarized in Figure 20.

B. SOFTWARE REQUIREMENTS

EDI software consists of computer instructions that translate information from unstructured, company-specific format to the structured EDI format and then communicate the EDI message. EDI software also performs this activity in reverse (receives the message and translates from

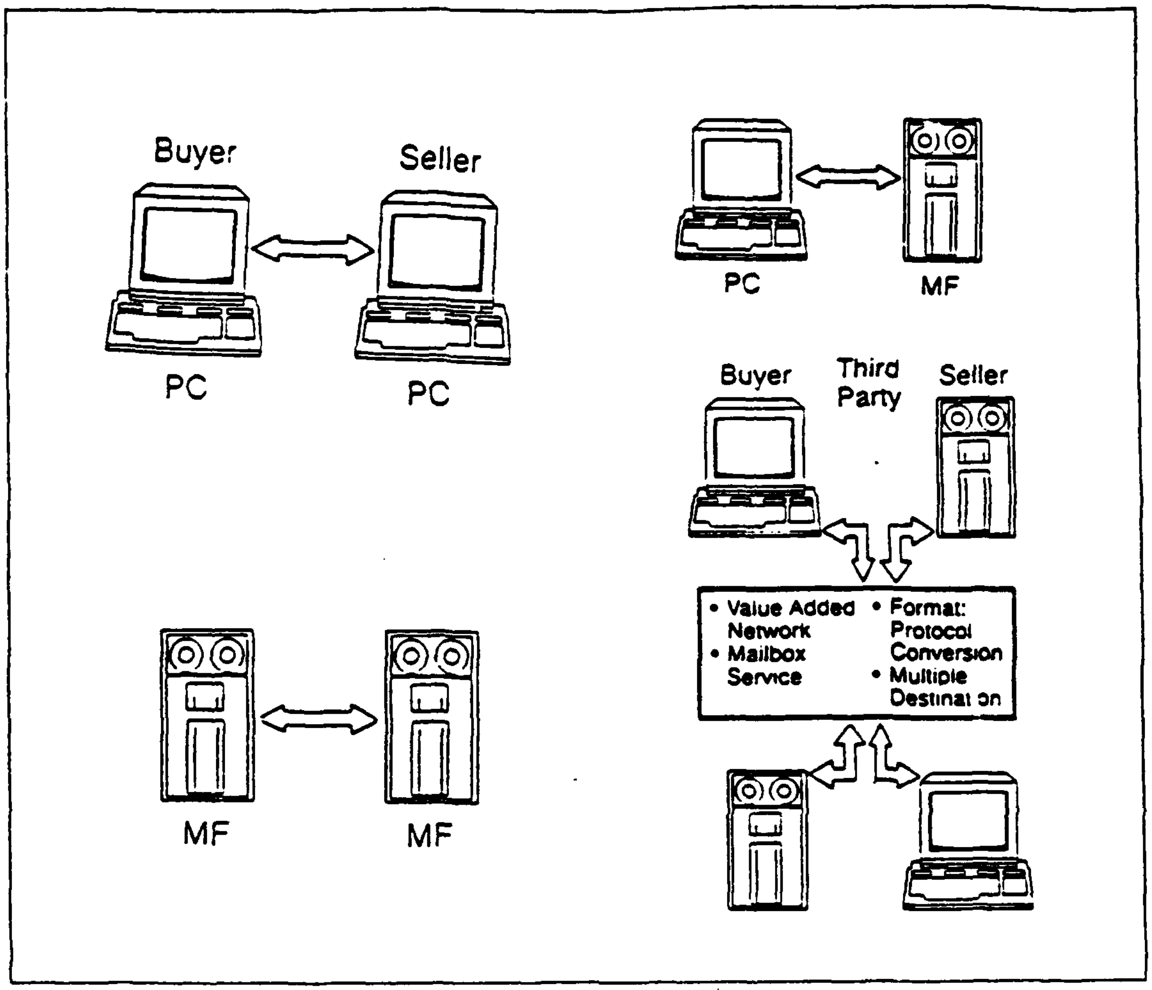

Figure 19. Hardware platform for EDI

standard format to company-specific format). EDI software can be developed in-house or it can be purchased from a number of commercial software vendors. EDI can be performed on various types of computers and software is currently available for EDI applications using mainframe computers, minicomputers, or microcomputers (PCs). The major func-

Sample Costs for Buyer	Advantages	Disadvantages
Hardware:$4000.00 Software : $1000.00 to $10000.00	Lowest system cost Allows for multiple stations	Limited data volume Harder to secure system Require each partner Same baud rate Same protocol
Hardware : $10000. to $100000. Software : $1000. to $20000.	Can handle high volume of data Larger Data Base Better security	Costs of hardware Same baud rate Require each partner
Hardware : $4000 Software : $1000 to $10000	Support Remote job Handle higher volume One-to-many EDI system	PC user limited Require each partner Same baud rate Additional software
Hardware: $4000. to $100000. Software : Variable	Better security Mailbox services Multiple destination Access to satalies Allow long distance	Added costs Addsadditional link to the EDI transaction cycle

Figure 20. Advantage and disadvantage

tion that EDI software performs is formatting or translation. Formatting software generally uses a table structure to perform the translation. The software includes tables consisting of the standard data dictionary and syntax rules for the data segments and elements of a given EDI transaction set. The actual transmission of the EDI message is controlled by communications software. This software manages and maintains phone numbers of trading partners, performs automatic dialing, and also produces an activity log.

Figure 21 [Ref. 3: p. 92] shows the normal sequence of activities performed by EDI software for both incoming and outgoing EDI.

There are a number of software categories associated with an EDI system. These include:

- Database management software: Designed to systematically organize data into files for easy access, retrieval, and update.
- Format/conversion or translation software: User information input into transaction format (ANSI X12) and then converted to the electronic transmission protocol. Also capable of converting transmitted data from the communications protocol to the transaction format (ANSI X12).
- Communication software: Controls the data being transmitted via phone lines to and from EDI partner. [Ref. 3: p. 66]

EDI software may be one of the following:

- Internally developed software
- Commercially available software
    - Database management software: ranges from $199.00 to $3,000.00.
    - Communications packaged software: ranges from $99.00 to $1,000.00.
    - EDI format/protocol software

Most of the following features are available in commercially developed software, and should be included in any in-house developed software.

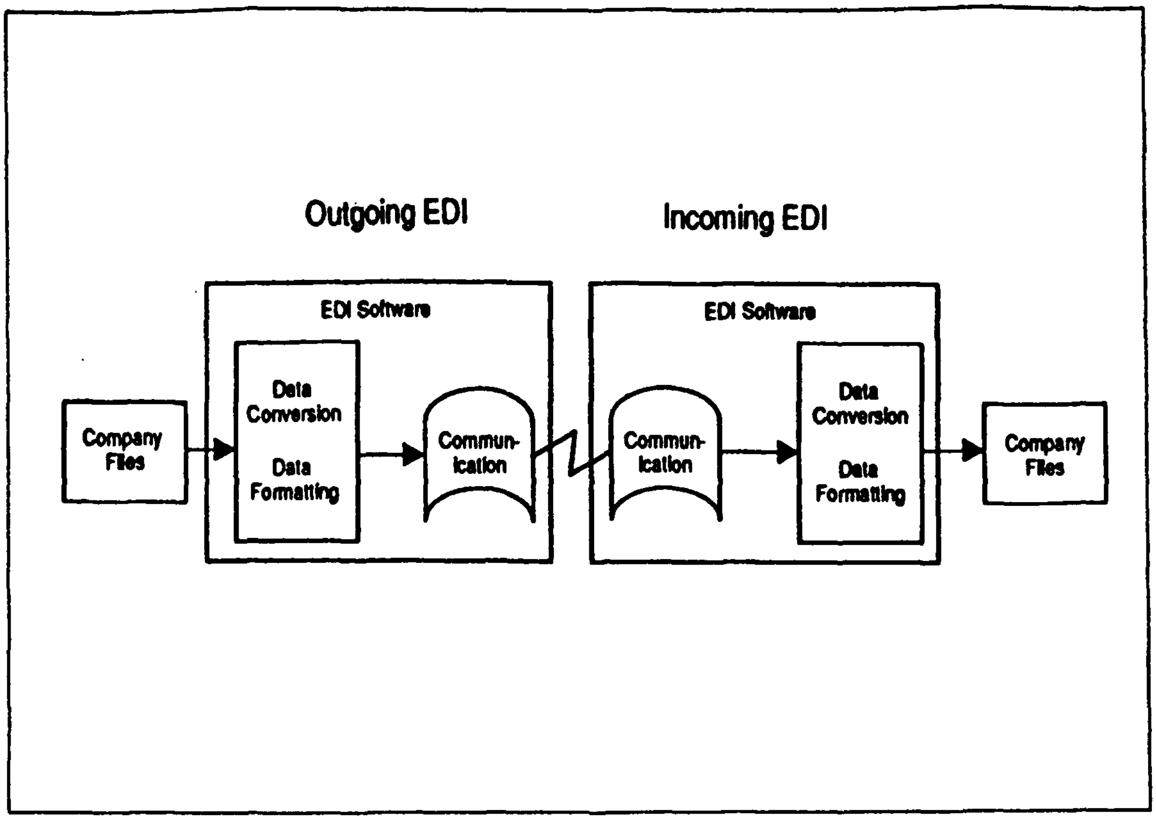

Figure 21. Function of EDI software

- Table-driven structure
- Editing capability
- Customize ease
- Audit options

Three major factors should be considered in determining whether your organization should buy a commercially available software package or it should develop the software in-house. They are:

- In-house resources
- Maintenance required

- Company policy

If your organization decides to buy rather than develop software in-house, you will be faced with selecting among a number of software vendors. In evaluating commerically available software packages and vendors, four major factors should be considered:

- Meeting needs
- Company experience
- User friendly software
- Vendor user-friendly

V. NETWORKING REQUIREMENTS

A. TELECOMMUNICATIONS INFRASTRUCTURE

1. COMMUNICATIONS STRUCTURE

The objective of the EDI system is to enter specific EDI transaction data once and then transmit that data in a computer readable format throughout the complete EDI cycle. Four approaches for computer-to-computer transfer of EDI transaction are described below and illustrated in Figure 22 [Ref. 4: p. 68].

- Mail or courier service delivering magnetic tape or diskette: Primary considerations of this method might be cost of transport, security of connection, and speed of delivery.
- Point-Point connection between partners: Both partners accommodate the same communication protocols and ANSI X12 format. Some considerations are cost of connection justified by volume of data, and speed of delivery.
- Value added network without translation: It provides mailbox service for both partners. accommodating ANSI X12 formats. Specific considerations include:
  - Easy adaptation of each partner's own line speed, protocol, multi-destination, time of day, etc.
- Value-added network with translation: It provides *mailbox* and X12 standard translation. Partners do not have to worry about translating standard formats, or do they negotiate line speeds, protocols, multi-destinations, and times of day.

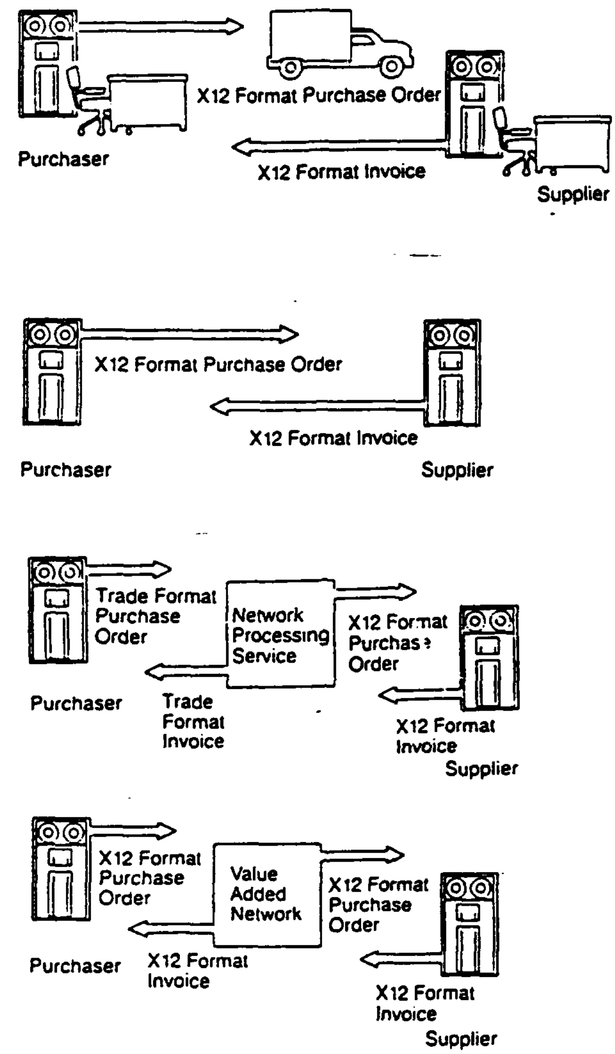

Figure 22. Approach for computer-to-computer transfer

A starting point for determining the most suitable communications services is to decide where in the organization the EDI application will be operated and who the end user will be. Invoice keying, order entry, just-in-time purchase, stock updating, delivery, customs and excise notification, and EFT (Electronic Funds Transfer) may occur in different departments staffed by different users. Four scenarios are examined to indicate the data communications options a company might adopt when introducing EDI. They are referred to as Integrated-External and Integrated-Internal (where applications require connection to the main process of the company in order for EDI to function) and Partitioned-External and Partitioned-Internal. The partitioned scenarios are situations where the EDI requirement applies to one end-user department for document exchange outside the company. The most suitable network solution and most appropriate protocols will be different for each of these scenarios [Ref. 5: p. 156].

a. Integrated-Internal network structure

The corporate network is already in place. The existing network would, typically, be based on a centralized star network configuration possibly with multiplexing or a peer-to-peer communications service based on a switched network configuration. Examples of these configurations are SNA networks and X.25 packet switching networks, respectively.

b. *Integrated-External network structure*

As with the internal structure, a corporate network is in place. External communications are also set up, perhaps bilaterally on private circuits or via PPSN (Public Packet Switched Network). The need for scheduling processing of documents will dictate the use of a store-and-collect facility which will typically be an external mailbox system. Integrated structures should consider all permanent external applications (EDIamong them) so as to achive economies of scale. A PPSN with X.25 interfaces, which offers the exchange of transactions securely to and from the company to more than one destination, best provides this sort of external network connection.

c. *Partitioned-Internal network structure*

This situation is a point-to-point requirement, typically PC to mainframe. The cheapest way of setting this up is by using the PSTN (Public Switched Telephone Network) as an adjunct to the mainframe's network ports, or a LAN where this exists. If volumes are high or security considerations rule out the PSTN, a private circuit connection to the corporate network will be required.

d. Partitional-External network structure

This is a simple configuration requiring no connection to the corporate network. The EDI application is likely to be developed on a PC and external communications will probably be via the PSTN to the EDI clearing house or correspondent.

2. PROTOCOLS

The main types of protocol and their suitability for an EDI communications service are considered first. Protocols in this instance refer to the station-to-station procedures for handling the correct transmission of data across a link and the data stream. The main protocols relevant to EDI are given below [Ref. 10: p. 26].

a. 3780 and 2780

These are block-mode protocols used for one way at a time (half duplex) exchange of data in batch. Commonly referred to as Remote Job Entry (RJE) they are used between processes--PC to mainframe, departmental mini system to mainframe. Partitioned network structures will find this method most suitable as it offers a widely available means of transmitting files error-corrected over the PSTN. The characteristics of the files are likely to be low volumes of data generated in a stand-alone PC. Most communications hardware suppliers support these protocols.

They have been established for many years and they originate from the early IBM data processing environment.

b. 3270 and 3770

Whereas 2780/3780 is the de facto batch protocol from the BSC environment, 3270 is the de facto screen display data stream. It is nearly always associated with SNA/SDLC (Systems Network Architecture/ Synchronous Data Link Control). SDLC is the link level transport mechanism, usually point-to-point cluster controller to FEP (Front End Processor), supporting and protecting the integrity of the 3270 data stream across the link. 3770 is used for batch work in the SNA environment. When the network structure fits the integrated network scenarios, 3270 and SDLC are appropriate.

c. VT100, TTY and CO3

In very many processes, documents are exchanged interactively by an operator or admin clerk filling in forms on a workstation attached locally or remotedly to a host system. In addition to 3270, CO3 and Screen VT100 apply. CO3 is similar to 3270/SDLC in concept and exists in the ICL (International Computers Limited) environment. VT100 is a character-interrupt protocol and is usually restricted to terminals which are directly attached to a DEC host system.

d. X.25

The X.25 protocol is the standard method of interfacing to packet networks. It is made up of three levels: the physical or line level where the control of the electrical interface is defined (V.24, V.35 and X.21bis); the link level which, with HDLC, ensures that data is transported across a link with integrity and under the control of both ends of the link; and the packet level where data is split into packets and are dynamically multiplexed such that many calls to many addresses can be transported simultaneously on a single link. X.25 defines the interface between DTE (Data Terminal Equipment) and the packet switch. The manner in witch data is handled within a network is not merely a function of the X.25 protocol but the design of the network itself. X.25 is suitable for the integrated network structure scenarios where corporate communications are based on X.25. Partitioned network structures can also opt for X.25 because the protocol is firmly supported by PC communication card manufacturers as well as all the main data processing officer automation equipment manufactures [Ref. 5: p. 159].

3. NETWORKS

More significant than the protocol is the network which is to be selected for EDI. This is because the selection can involve investment decisions which are far more important, particularly for the integrated network structures. In selecting the appropriate type of networking for EDI, the breadth of applications which the network is required to carry needs to be considered. EDI is usually going to be only one of many applications in an organization.

a. Separating the functions

The relationship between the EDI application and the transport network should be considered case-by-case when deciding which EDI solution to adopt. The functions which the EDI application provide and the network needed to connect the application are conceptually independent. The EDI application is a processing problem---that of conversion, storage, collection, and auditing. The network is an infrastructure problem, the bearer of a wide variety of applications, economic wide area access, and where needed, routing, resilience, multiplexing, switching, and data stream and protocol conversion.

b. Network management

A good network management and maintenance operation is essential to sustain a high quality of service. This applies to any data network which is capable of providing the communications infrastructure for a company's internal and external networking needs. This is the area which requires the most expense in skills. The cost of doing this often outweighs the capital investment of the equipment in the network. The EDI User should where possible take a advantage of third party service because the financial structure of the business may not afford the wide area network investment and running cost. The other significant issue in deciding whether a third party EDI service provider has the appropriate network solution for the company who wants to integrate external EDI within his company (the integrated-external scenario) is the extent of geographic coverage provided by that third party service provider.

c. Public and Private network

One of the main determining factors when deciding between public and private networks is the cost. It is often actually cheaper to use a Public Data Network than for the company to build the network for itself. This is especially so when all related costs are included; that is to say, all equipments including network management tools, skilled staff resource, and all reased items such as private circuits. As an example, the comparison for a 22-site network spread nationally is shown in Figure 23 [Ref. 5: p. 161]. Costs of using the Public Data Network comprise connection charge and quarterly rental for each data line (direct connection)

	Build Your Own		Public Data Network	
	Start Up	Recurring	Start Up	Recurring
Year 1	108	102	20	89
Year 2	-	107	-	89
Year 3	-	107	-	89

All figures are in £,000s

Figure 23. Full cost comparison of network implementation options

from the customer's equipment. A list and a visual representation of the main Public Data Network services is shown in Figure 24 [Ref. 5: p. 163].

B. USE OF THIRD PARTY NETWORKS

Third party networks are not used by all organizations that have implemented EDI. However, recent estimates place the percentage of organizations that have implemented EDI and are currently using third party networks at approximately 60 percent of all EDI users. While it might seem logical that large organizations would be the least likely to use third party network services, approximately 75 percent of the Fortune

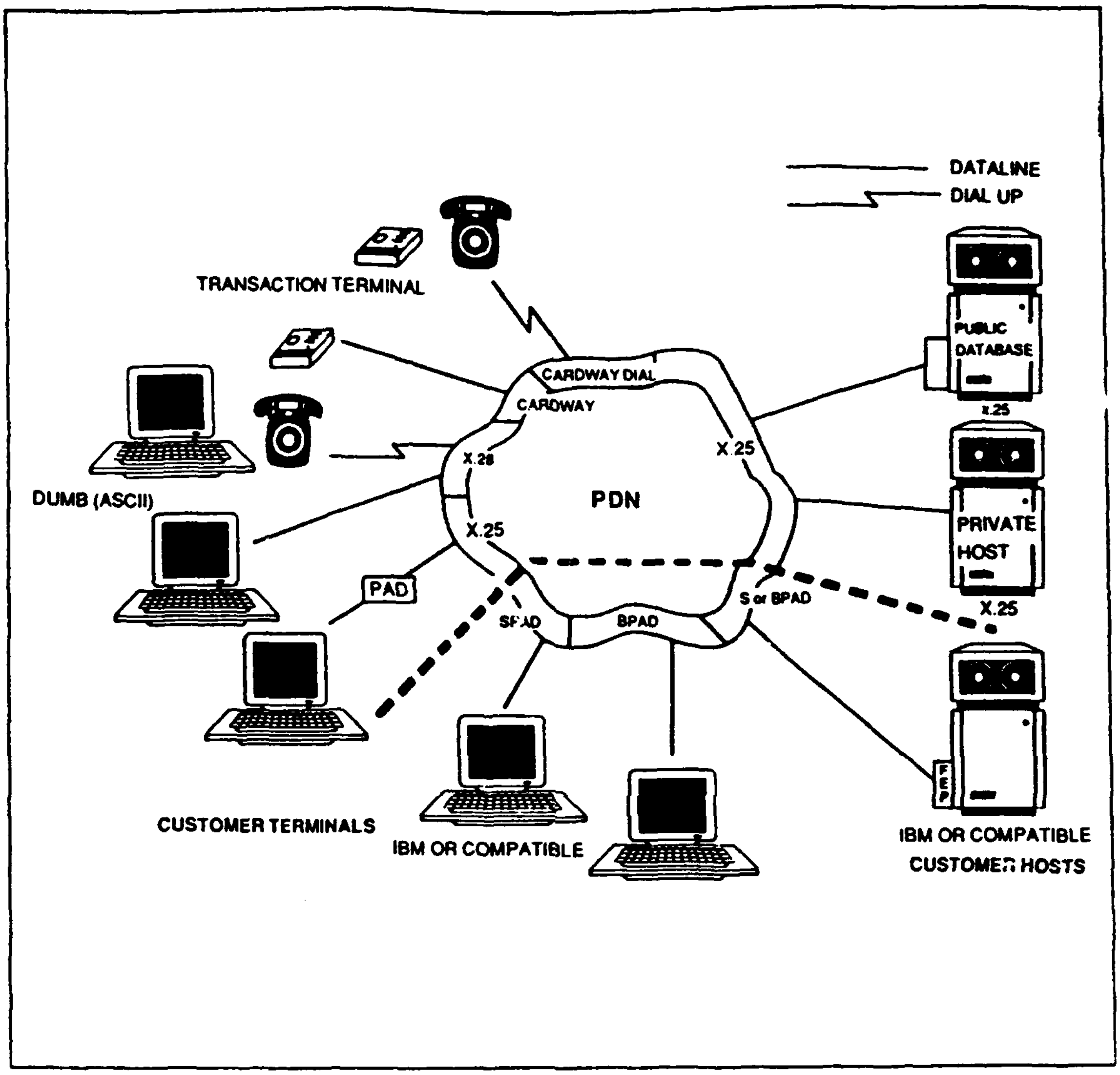

Figure 24. Public Data Network Service

500 companies who perform EDI use third party networks to some extent. Further, as the use of EDI continues to expand, the use of third party networks is also expected to expand. Most of the growth in EDI is likely to come from the implementation of EDI by small and middle-sized

companies as their larger trading partners begin to demand EDI transactions. Many of these companies do not believe that they have the in-house resources and skills necessary to establish direct EDI linkages with trading partners. Further, even in organizations where resources are available, many organizations have found that the use of a third party network relieves much of the systems development burden.

There appear to be a number of key issues that require consideration by organizations considering the use of third-party Value Added Networks or a third-party network in particular [Ref. 4: p. 77].

The first issue is whether to use a third-party network. The answer is primarily dependent on the firm's systems experience, transaction volumes (overall and between buyer and seller) and current and future states of your firm's computer hardware. With an experienced firm with significant hardware, direct computer-to-computer links with selected key suppliers may be appropriate. For the largest multitude for firms, it appears that the use of a third-party network for EDI may be most appropriate. Once the decision to use a third-party network is made, then the decision criteria discussed can be applied. There are a few most significant issues that become critical when selecting a specific third party provider. First, it is important to determine that the provider has both the commitment and financial resources to stay in business. It is essential that they provide continuity and continuous system enhancements.

Secondly, it is imperative that the third party provider has the capability of *gateway* to other third parties. It is important that the provider has two-way access to other third parties being used by the suppliers (and customers) to guarantee a smooth flow of data. Figure 25 [Ref. 4: p. 78] identifies a number of third-party Value Added Network providers and lists who they gateway with (as reported by the third-party networks themselves).

Thirdly, it is important that the third-party be able to do business on a worldwide basis, if your firm is a global participant. The need to interface with foreign suppliers is an important, if not more so, than with domestic firms.

Fourthly, your firm and the third-party should be active in furthering development and acceptance of inter-industry standards such as ANSI X12. Further development and refinement of these standards is extremely important to EDI and to fostering electronic communications.

Finally, the third-party network should be working with other kinds of organizations such as financial institutions, trading companies, transportation firms and so forth. This will increase the likelihood of devel-

	General Motors/EDS	GEISCO	McDonald Douglas	IBM	Kleinschmidt	Telecom Canada	Control Data	TranSettlements
General Motors/EDS	Y	Y	Y	Y	Y	Y	Y	Y
GEISCO	Y	Y	Y	N	Y	N	Y	N
McDonald Douglas	Y	Y	Y	N	Y	Y	Y	Y
IBM	Y	N	N	Y	Y	N	N	N
Kleinschmidt	Y	Y	Y	Y	Y	N	Y	Y
Telecom Canada	Y	N	Y	N	N	Y	N	N
Control Data	Y	Y	Y	N	Y	N	Y	Y
TranSettlements	Y	N	Y	N	Y	N	Y	Y

Figure 25. Selected third-party value added network gateways

oping electronically integrated purchasing, manufacturing, transportation and financial systems. the firm should then be able to benefit from any innovations.

VI. AUDITING AND SECURITY ISSUES

A. AUDITING

In any EDI system, managers need to substantiate that the system is processing information correctly. This substantiation is provided by the capability to track any transaction to its closing. This physical tracking of a transaction through the system is called the *audit trail.* Since the audit trail is a primary source of information for purchasing professionals, it is imperative that an adequate trail be available to them for verification purposes. In the EDI environment, the record of purchasing transactions between the buyer and suppiler is electronic rather than paper based. This change to electronic documentation impacts the manner in which the purchasing function controls the buying process.

The degree to which the EDI system impacts the purchasing control process depends primarily on the level of sophistication of the EDI system. Physical documents such as manufacturing order releases, invoices, advance shipping notices, and bills of lading continue to exist and can be used as check mechanisms. As more vendors and document types are added to the EDI system, effective auditing and control procedures need to be designed into the system. With effective planning, controlling the

EDI system is relatively painless. Several elements are needed for the cost effective control of an EDI system. Those include:

- Well defined and clearly written job procedures.
- A systems user guide that parallels and complements the job procedures.
- Systems technical documentatin.
- A well-run data center. [Ref. 11: p. 23]

The amount of time, effort, and resources placed on designing an effective EDI control system depends upon the level of sophistication of the particular firm's EDI and automated purchasing system. The procurement manager must understand the auditing and control issues created by the use of an EDI system. The manager must have a knowledge of the function and use of these control mechanisms. The emphasis when designing procedures of the EDI system should be on the day-to-day control of the system. The control procedures must be good enough so that any kind of discrepancies that arise can be resolved and legal requirements satisfied.

The EDI system must address the system concerns of auditing. It is important to involve auditing in the EDI planning and implementation process. Effective system auditing and storage procedures can only be effectively built in early in the EDI system design and implementation processes. The type and nature of control mechanism should be determined jointly by purchasing and auditing. Many of these controls must be designed into the EDI system before the system is placed on-line. Adding control mechanisms after the system is in operation is costly and could affect the cost-effective functioning of the EDI system.

Auditing, although an important issue, can be successfully managed. The issues and concerns can be systematically addressed. It is incumbent upon every professional user of the EDI system to ensure that the system is performing as intended. Auditing issues must be addressed early in the EDI implementation. Auditors have been dealing with electronic data processing systems for years. They must utilize the knowledge of auditors in designing and implementing the EDI system controls.

B. SECURITY

The security of electronic data is a continuing managerial problem. Security issues for other internal computerized systems have many of the same characteristics as those associated with EDI systems. Security issues involving EDI should be viewed as an extension of current security issues, procedures, and standards which many organizations have already addressed with other computerized systems [Ref. 4: p.48].

The major difference between EDI and puchasing system security is that persons external to the organization are involved. Vital information concerning pricing, contracts, quotes, and purchase orders are routinely transmitted electronically in the EDI environment. It is imperative that this information be secure and accessed by only authorized parties. Problems such as sending a purchase order to the wrong supplier must be avoided. Without proper monitoring and technological safeguards, information could accidentally or deliberately be made available to the wrong party.

EDI security systems are required because information has value. The protection of the purchasing data base and maintaining the integrity of the data transmitted are the goals of the security system. Access restrictions should be established by policy and enforced by written standards and procedures.

Protective security measures are built into each of three security elements. First, Physical security measures restrict physical access to the system. Examples include locked doors, keys, guards, alarms, etc. Second, procedural security measures provide controls over authorization to see or use information. Examples include authorized employee lists, information elements access approval, passwords, and separation of duties. Third, logical security measures restrict access to information in electronic forms. Examples include software systems which implement access control through the use of fingerprint recognition, voice recognition, and data transformation and encryption. In a technologically complex system, protection often requires a combination of all three security elements.

Management should first subjectively and objectively look at the nature of the information involved in the EDI transfer. Security standards should directly reflect the value and sensitivity of the information. For information that is of high value to the organization, stringent security standards should be implemented.

A well-designed security system ensures information availability to authorized user personnel, but at the same tirne protects the integrity of the data and the system. EDI security should be viewed as protection of the purchasing data base, the physical hardware, and the transmitted data. Security concerns occur through the entire EDI system, therefore EDI security must address both the external as well as internal environment. Identifying potential problem areas before the EDI system is put on-line will aid in the design of a fully protected system. Figure 26 [Ref. 4: p.50] presents the information flow from initial data base creation through information dispersion to the supplier network. All nodes and links of this system should be carefully analyzed for security.

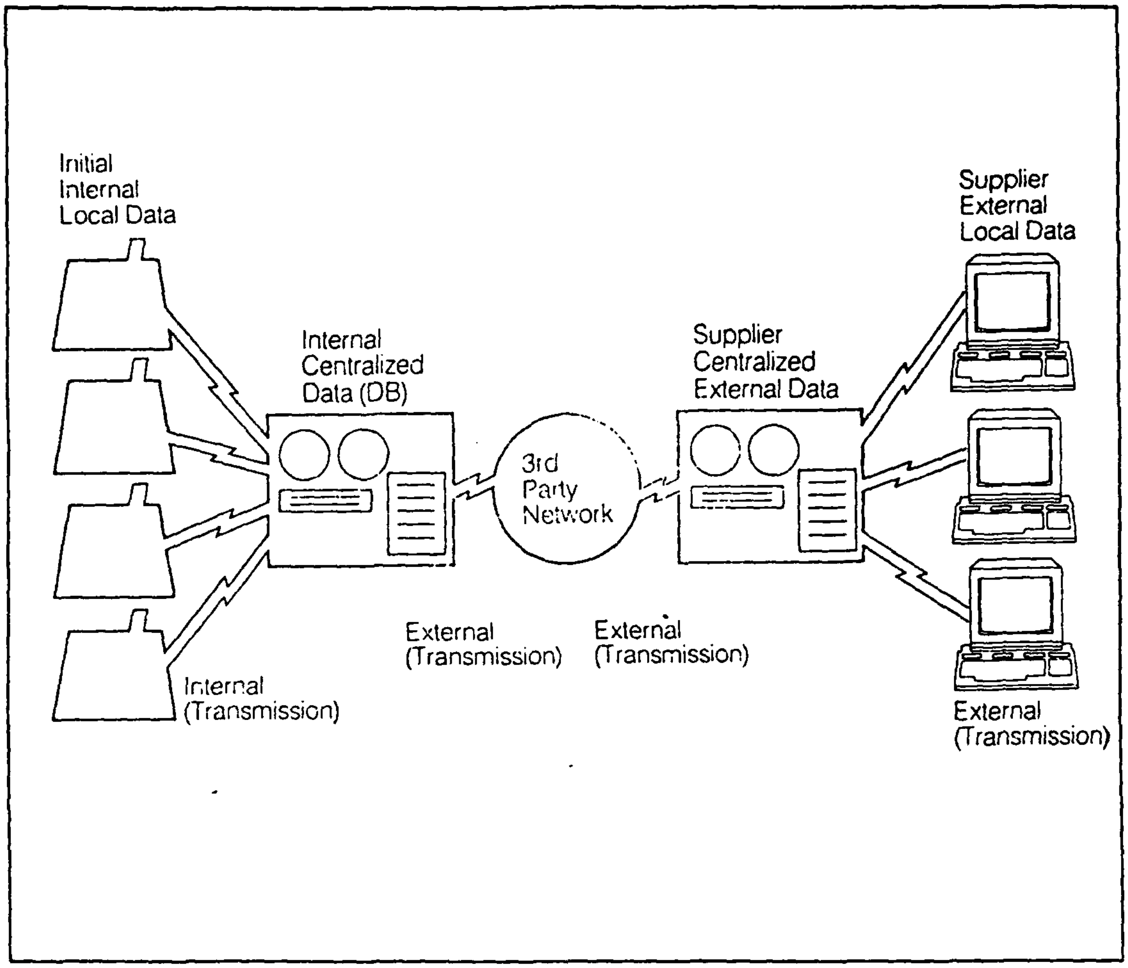

Figure 26. Threats from transaction of data from nodes

VII. CONCLUSION

EDI is headed *up* in terms of volume of usage and is headed *in* in terms of integration with other management concepts and technnologies. Exponential growth is expected in EDI usage in the next few years. It is predicted that by 1993 over 70 percent of U.S. firms will be making significant use of EDI. By 1995, over 400,000 companies worldwide will be communicating electronically. The growth is expected to come from a number of directions. The United States is currently ahead of all other countries in terms of level of EDI use. However, other areas of the world are begining to catch up. Major EDI efforts are underway in Canada, Western Europe, the Pacific rim, and the Soviet Bloc, as well as in other parts of the world. One estimate places the annual growth rate of EDI worldwide at about 88 percent a year over the next three years [Ref. 12: p. 67-73].

EDI also going to expand *out*. New and different applications of EDI will be used. Currently, EDI is used for the communication of standard business documentation in a structured format. The communication is done using EDI standards and EDI networks. However, much of what is communicated in business does not fit that category. Electronic mail, voice imaging, and videotext are currently being used to some degree for business communications. It is expected that EDI technology will eventually expand to allow for the incorporation of such communications methods. EDI does not provide for the communication of drawings or graphics since these do not fit a standard structured format. However, the expansion of EDI to incorporate such items appears to be underway, as evidenced in CALS. At least one software supplier has announced that its EDI software can be used for the transmission of engineering drawing and graphics in CAD/CAM format.

EDI has become an accepted and fairly standard method of communication within the auto industry, more efforts are being undertaken to closely integrate EDI within internal systems, including JIT scheduling, information systems and Common Manufacturing Management Systems (CMMS).

Legal considerations were seen as the major obstacle to implementing EDI. Terms and conditions which legally serve to bind and protect the buyer and seller would no longer accompany each purchase order under electronic transmission. Legal counsel can alleviate this obstacle by drafting blanket agreements covering all responsibilities and obligations of the buyer and seller. This agreement needs to be signed by both parties prior to broad-scale EDI start-up [Ref. 13: p. 25].

Another concern involving EDI implementation is the security issues associated with transmission of business information through an external network. Information has value and must be protected. Internally information is protected via password or authorization codes. The safeguards that exist internally are also available for use in the networking environment. Before selecting a vendor who provides networking services, a thorough evaluation of their security methods must be conducted.

EDI will be essential to the procurement process making a key contribution to the firm's competitive advantage. EDI plays an important role in the procurement strategy of leading edge firms. Application of EDI will be increasing dramatically in the future on a worldwide basis. Extensive growth of EDI is on the near-term horizon. EDI is fast reaching the point where it will become a requirement to do business. Significant benefits, in the form of reduced costs, improved productivity, and better information, result from EDI.

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